1902 - 1904

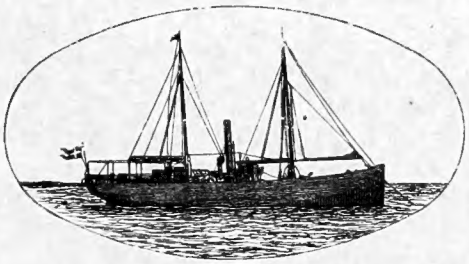
Report

of

The Danish Biological Station

to

The Board of Agriculture.



XII.

1902 and 1903.

By

C. G. Joh. Petersen,
Ph. D.

Translated from **Fiskeri-Beretningen for 1903—04.**

Kjøbenhavn.
Centraltrykkeriet.
1905.

From

The Danish Biological Station.

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Contents.

I.

Where, and under what Conditions, can the Eggs of Plaice be developed into Young Fish within the Skaw?

By C. G. Joh. Petersen.

Contents.

Introduction.

Twenty years have passed now since *V. Hensen* published his original and beautiful studies on *the eggs of the plaice* in the western part of the Baltic Sea, and it is some ten years since I started the question of the occurrence of *the fry of plaice* on the Baltic shores. But not till these last years have any new data been published, which throw light on the question *whether the plaice is able to live through its whole development, from egg to grown-up fish, in the various parts of the Baltic Sea.* Not till now, therefore, we can begin to form an opinion on such questions as: In which regions is it possible? Is it possible every year? To which extent may it be supposed to contribute towards the preservation of the whole stock in the various places? These questions are not by far solved as yet; they have been set forth only with greater precision. The whole matter still deserves renewed investigation, if it is to be of that use to practical fishery which a close understanding of it seems to promise. Therefore it has been taken up also for international investigation in "Commission C" for the investigation of the Baltic Sea.

In "Abhandlungen des deutschen Seefischerei-Vereins", vol. VII, 1902, *Schiemenz* writes about the fishes from the *Holsatia's* cruise in the Baltic Sea. In "Wissenschaftliche Meeresuntersuchungen, Neue Folge", vol. VIII, Kiel 1904, *C. Apstein* writes in "Junge Butt (Schollen, *Pleuronectes platessa*) in der Ostsee" about the young plaice which of late years have been gathered on the shores near Kiel. In "Wiss. Meeresunt., Neue Folge", vol. VI, Heft I, 1904, *Ehrenbaum* and *Strodtmann* write about "Eier und Jugendformen der Ostseefische", gathered as pelagic eggs and young fish on the *Poseidon's* terminal cruises in the Baltic, and *A. Krüger*, ultimately, writes "Über die Verbreitung junger Schollen an der deutsche Ostseeküste 1903", "Mitt. des deutschen Seefischerei-Vereins", No. 12, 1903.

These four publications, which are all closely connected with "The International Exploration of the Sea", give a report also of what has formerly been published about these matters, more particularly the works of *Ehrenbaum* and *Strodtmann*. I shall refer to these publications, therefore, and here only try to give a brief summary of the main points of the whole matter, and to state what is known already, basing my statement partly on these published papers, partly on unpublished investigations of the Danish Biological Station. Finally, I shall mention certain facts to which we ought to pay particular attention in future, if we want to gain a clearer insight into the matter.

To avoid misunderstanding, I shall premise the observation that the "Baltic Sea", here, stands for the waters south of the Danish islands and eastward; the "western part of the Baltic Sea" for the waters south of the Danish islands as far as the line Gedser-Darserort; the "Baltic Sea proper" is the sea east of this line and south of the isle of Saltholmen, near Copenhagen; while the "Belt-Sea" stands for the waters around Samsø, the Great and the Little Belt, and the western part of the Baltic (Cmp. the map, p. 8). These limitations I have already used for many years, for hydrographic-biologic reasons, and I consider them, in this respect, suitable and defensible. (Cmp. "Kanonbaaden »Hauchs« Togter".)

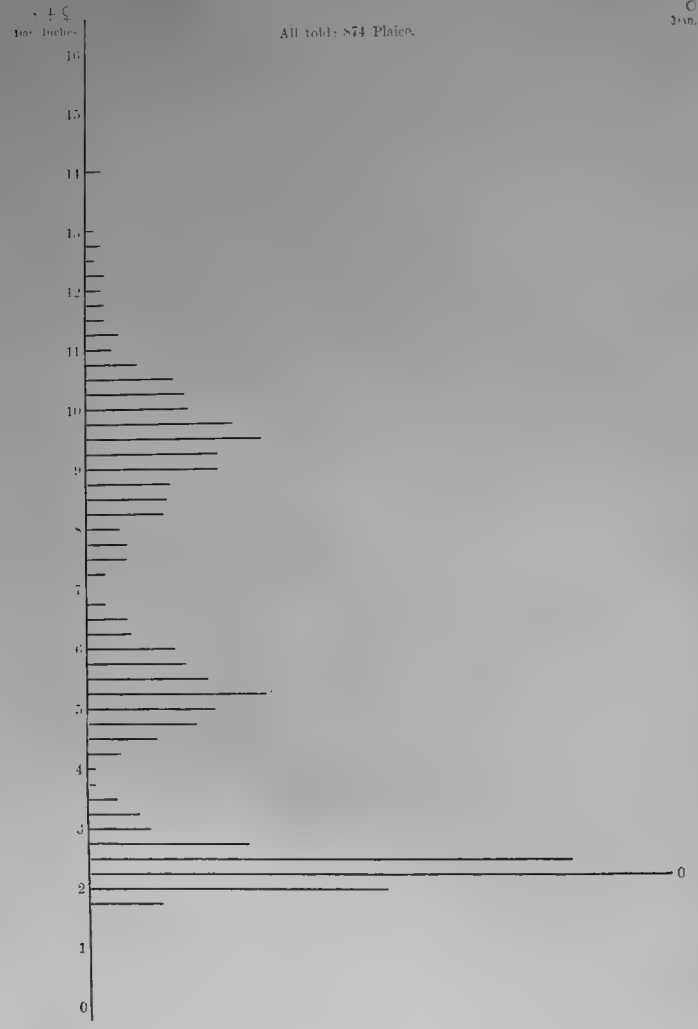
On the Stock of Plaice in the Cattegat, the Belt-Sea, and the Baltic Sea proper.

If we will take some pains to catch plaice of different sizes in the Cattegat, as a rule also in the Belts, partly by employing fishing-apparatus with small meshes, partly by fishing on deep as well as on low water, it will be proportionally easy to get them in great numbers and of sizes like those represented in table I, columns I & II. We see here, among others, the smaller ones, the fry of the year (the 0-group), 1—c. 4 inches ($2^1/_2$—c. 10 ctm.) in length, in great numbers. These little fish are caught on low

Tabel I.

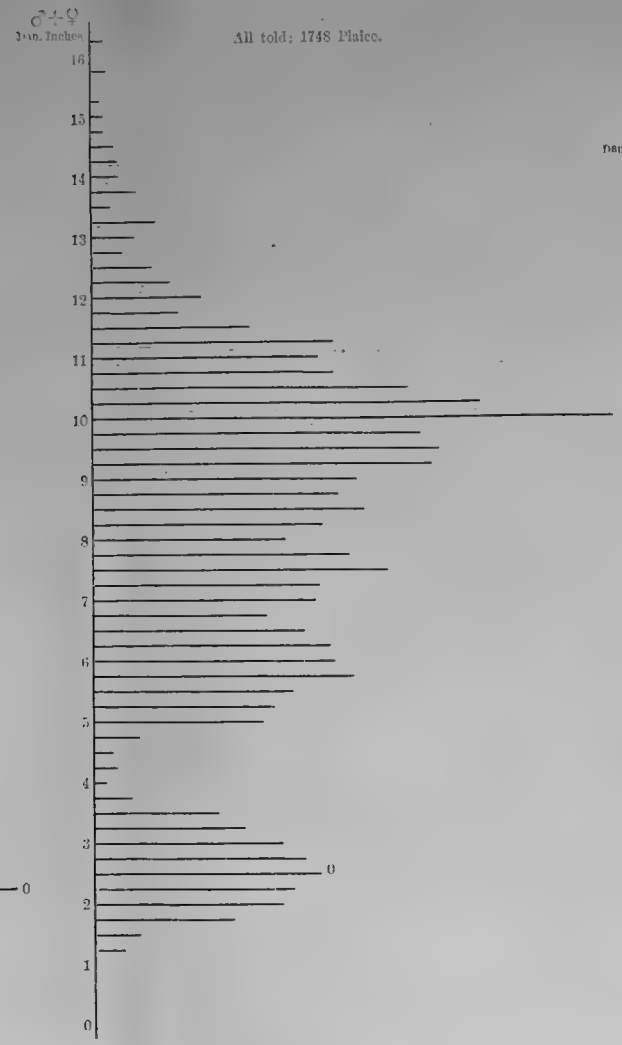
Colonne I. *Kattegat (Djursland).*

8—10 Septbr. 1902. 0—10 Fathoms.



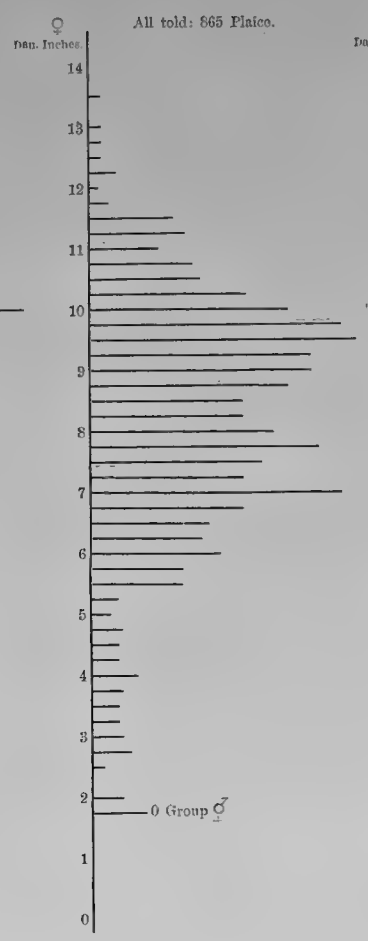
Colonne II. *Store Bælt.*

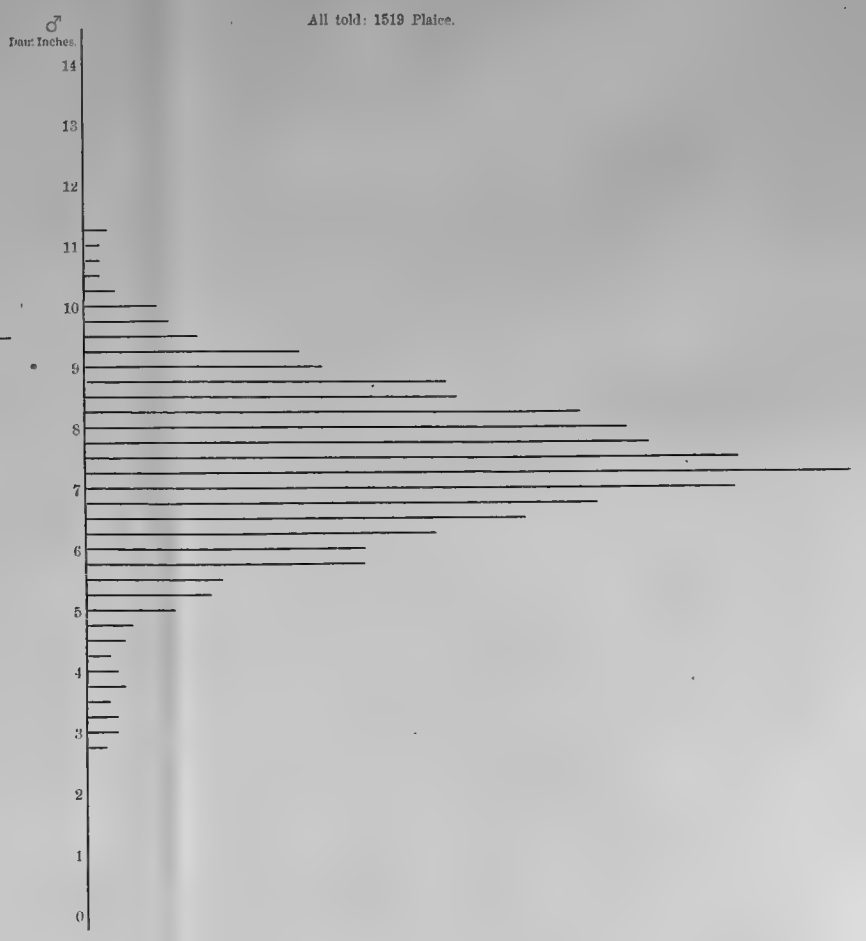
End of August and in Septbr. 1901 and 1902.



Colonne III. *The Baltic.*

2.—5. Septbr. 1902. S. E. of Møen. 0—ca. 14 Fathoms.





The horizontal lines indicate the number of measured Plaice. 1 Millimeter indicates 1 Plaice.
1 Dan. inch = 26 Millimeter.

(To be bound between pg. 4 and 5. Report XII. Dan. Biol. Station.)

water, on the shores, where the latter are sandy and have not too much vegetation, and are not too exposed to the direct dashing of the waves. Where the dashing of the waves is too heavy, the sand is often coarse and barren; but where there is some shelter, and the particles can remain among the grains of sand, there the small plaice of the 0-group prefer to live. The growth of the preceding year, however, the I-group, which in the autumn is c. 4—7 inches (c. 10—18 ctm.) long, is also frequent. It is partly found together with the 0-group on the sand, though as a rule on deeper water. Where there are stones and a rich vegetation, as, for instance, *in the Belts on 2—7 fathoms*, it may often be troublesome enough to catch this group, because the fishing-apparatus (Petersen's trawl or English trawl with small-meshed codend) is apt to take hold of stones or be filled with plants. That it can be done, however, is shown by table I, column II. In the Cattegat it is, as a rule, owing to the conditions of the bottom, easy enough to catch the group in great numbers. In the following groups, II & III, which I shall not here make the subject of any closer examination, several of the largest specimens, from c. 10 inches (c. 25 ctm.) and upwards, are grown-up fish. But as a whole the group between 7—14 inches (18—37 ctm.) cannot be looked upon as the grown-up group properly so called. This is missing in the tables as a particularly pronounced group, and probably also in nature. If, on the other hand, we go down into the *Baltic Sea* proper, for instance into the sea outside the isles of Falster and Møen, and try to make a similar arrangement of all the groups there, by fishing from the shore where there are splendid sands, seemingly well suited to be the dwelling-place of the 0-group, and out on the deep sea, then we get quite another picture (Cmp. table I, column III). Here the stock consists, almost exclusively, of a group of really grown-up fish, the males from c. 5 inches (c. 13 ctm.) and upwards, and the females from c. $5^1/_2$ inches (c. 14 ctm.) and upwards. In spite of all seeking for small fish, both on the deep and on the shallows, we have succeeded in getting only very few specimens which may be supposed to represent a 0 and a I-group. The females of the grown-up group have here very large ovaries and are furnished with white rings around the red spots (*Pl. borealis*). See "Publications de circonstance Nr. 1. Conseil permanent international pour l'exploration de la mer". It was impossible, in the month of September, to determine the maturity of the males, but this has been done on other occasions; these also have white rings.

That the smaller plaice could not have escaped us if they had been living in this part of the Baltic, is proved by the fact that we caught many other small fishes, both flounders (*Pl. flesus*) and common dabs (*Pl. limanda*); the small flounders *on the shores* in shrimp-nets and ammodytes-seines, the small dabs *on the deep sea*. There is no doubt that the small plaice of the 0-group and the I-group were rare in these seas, not only compared to the large number of grown-up fish, for these are here more numerous than any

where else on the shores of Denmark, and only near Iceland have I seen them in such numbers; but also absolutely considered the 0-group was rare, as the time spent on these investigations has often shown me.

Something similar to this has been the case also in other years, as may be proved by a reference to the "Report of the Danish Biol. Station, IV, 1893", tables VII & VIII (from the the same seas and from the isle of Bornholm), which show that only 3 plaice under 13 ctm. were caught at Bornholm, but a great many over; and at the isle of Møen none at all under 8 ctm. Table X, loc. cit., on the other hand, shows many flounders as small as $1^1/_2$—2 ctm. at Bornholm.

These remarkable differences in the occurrence of the fry (the groups 0 & I), its frequent occurrence in the Cattegat and, partly, in the Belt-Sea, and its rarity in the Baltic Sea proper, have from the beginning seemed to me to be of the greatest importance with respect to the renewal of the stock. The scarcity of the fry on *all the Danish shores of the Baltic Sea* during the years in which I investigated the matter, also on the shores of the western Baltic Sea, made me suppose that the fry was scarce, also on the corresponding *German* and *Swedish shores* from which we had no information. I had so much the more reason for this supposition, as it was directly supported by the investigations of *Apstein* in August 1893 (loc. cit. p. 3), who found, near Eckernförde, only one young plaice, but 153 flounders. Later investigations on the German shores have proved, however, that a great number of small young plaice, in certain years at any rate, are found on the shores from Eckernförde to Warnemünde; *but very few have been found east of the Line Gedser—Darserort.* On the shores of Bornholm I myself and my co-workers have in certain years taken some specimens; also, but very few only, on the shores of Falster and on deeper water S. E. of the isle of Møen (See p. 4, table I, column III, 1902). The *Holsatia* found one specimen, 2 ctm. long, on deep water; but *Schiemenz* himself writes after his expedition in the Baltic: "Auffallend ist, das der erste Jahrgang (mit einer Ausnahme) vollkommen und auch der Anfang des 2. Jahrgangs fehlt. Dies stimmt also gut mit *Petersens* Anschauung überein". l. c. p. 180.

The Distribution of the Fry along the Shores.

In 1902 *Johs. Schmidt*, on board the Biological Station's steamship *Sallingsund* made a very close investigation of the Danish shores for the purpose of studying the distribution and numerousness of the fry of plaice. His results are given below.

"*The distribution of the fry of the year (the 0-group)*" was investigated, particularly in the months of June and July, 1902, on the shores, on low

water, with shrimp-nets (one of bobbinet, with very fine meshes, another with more open meshes, 9 mm from knot to knot), and nearly always by *wading* with the nets, i. e. when the water was sufficiently low; which was generally the case in all places where the fry of the year occurs in this season. The places which are specially suited for the occurrence of the fry of plaice are *flat sand-banks* with *shallow* water (2—3 feet), which can be heated through by the sunbeams, and with a clean, sandy bottom without any vegetation and without any great interspersion of organic substance. In places where the shore was so steep that it was impossible to wade, we made use of a shrimp-net from the jolly-boat, kept in place by a man in the stem, while another man was rowing. In this way we sometimes caught pretty much, though never so much as when we were wading, when it was much easier to give the apparatus the suitable speed, so that none of the larger and quicker young plaice could escape. Later in the year, in the end of August and in September, we also employed, now a bait-seine with very small meshes, now a *small-meshed ammodytes-seine* ("inch-seine") for the catching of young plaice. From these investigations, the results of which are partially to be seen on the map, p. 8 and table II, we learn more particularly the following.

On the Occurrence of the Fry on the Sea-shore on Low Water.

On the Shores of the Cattegat we found the fry of plaice everywhere where we were looking for it, except where too much fresh water from rivulets is intermixed. In such cases it is replaced by the fry of flounders, for instance at the mouth of Mariagerfjord where, otherwise, the bottom is excellent for the fry.

In *the Little* and *the Great Belt* together with the adjoining seas (the archipelago south of Funen and the Langelandsbelt) the fry is found everywhere in suitable places, with the sole exception of Marstal Sande where, moreover, the fry of the year of flounders is not found either. If we now go *eastward to Smaalandshavet*, the number of the fry decreases. At Fejø we found c. 25, at Glænø some few, at Knudshoved 1, and *farther eastward none at all*, neither in Grønsund nor Ulfsund. At *Rødsand* and S. of the isle of Møen[1]) at Klintholm harbour there were excellent sand-banks, but not one young plaice was found here, nor did we find any on the northern shore of Møen, in *Faxebugt*, *Køgebugt*, or on *the shore of Amager*. We may say, therefore, that the fry of plaice *was missing in the Baltic Sea proper* and in *the southern part of the Sound*. We meet it again in *the northern part of the Sound*, from Strandmøllen, but here as well as more northward in the Sound in small numbers only.

The Isefjord. The fry is found here only just at the mouth of the fjord; higher up in the fjord it is quite missing. This is the case perhaps

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[1]) Off Bøtøgaard, in South-Falster, on the 4. Septbr., we caught a young plaice, 3 inches long, on $1^1/_2$ fathom of water.

in all the fjords, corresponding to the state of things in the Great Belt — Smaalandshavet — Eastward, where the salinity is decreasing just as in the Isefjord.

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The size of the fry of plaice may be very different in the various localities at the same time of the year (Cmp. table II). This is particularly striking at two places situated so near to one another as Fænø in the Little Belt and Baaringvig. At the former place the fry is grouped round 15 mm, at the latter round 35, though the gatherings have been made on the same day. The said example is the most striking, but several others show something like it, as may be seen from table II.

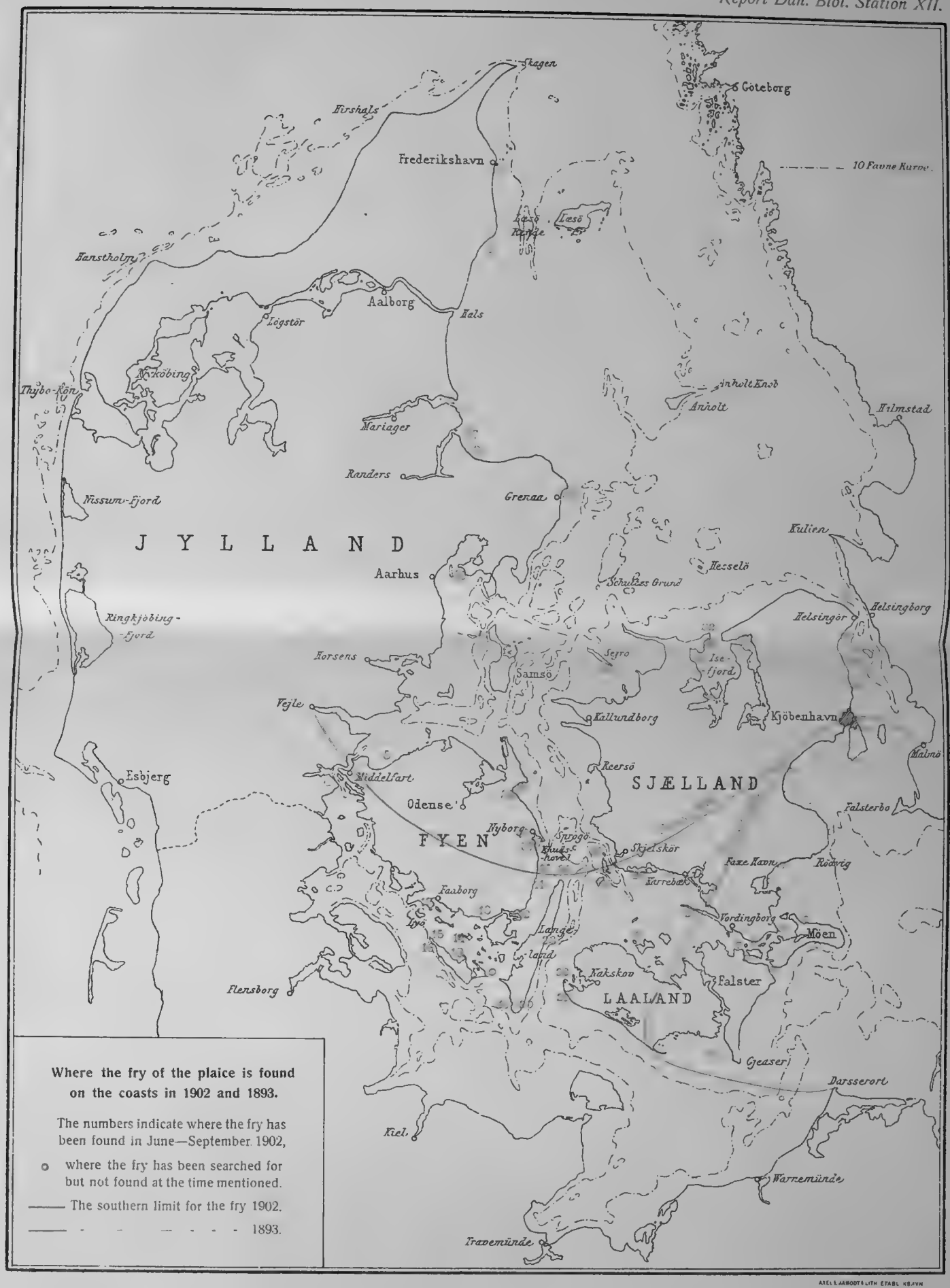
In some localities the seize of the fry has been investigated *on the same spot, at various times of the year*, in order thus to get an idea of the average size of the growth. I shall here give two examples.

Hevringholm (N. of Djursland. — Stations 3 & 37, table II). The 19. of June the average size of 124 young plaice was 25 mm (i. e. the largest group were 25 mm). The 8. Septbr. we caught on the same spot 335 young plaice, the largest group of which were 60 mm. The young plaice had then grown, on an average, 35 millimeter, from June 19.—September 8., i. e. in 80 days, or, if we suppose the growth to be uniform in these summer months, $^{35}/_{80}$ mm a day, consequently *a little less than half a millimeter a day.*

Holckenhavn (Nyborg Fjord). (Stations 10 & 14, table II). Here we find from July 7.—Aug. 21. a growth from 25 mm—50 mm, or 25 mm in 45 days, i. e. *a little more than half a millimeter a day.*

While all the hitherto mentioned young plaice of the 0-group have been taken on the shores, on low water with sandy bottom, we succeeded, in the beginning of September 1902, to prove beyond doubt the occurrence of specimens of the 0-group on *deep water*, $10^1/_2$ fathoms, in *the Baltic Sea*, viz. S. of the isle of Møen with Hestehoved N. $^1/_2$ W., on hard, sandy bottom with Mytilus, where they were caught with Danish trawl in a number of 16, together with specimens of the 1-group and older plaice, as also one young flounder of 24 mm and one young common dab of 30 mm. In this connection I shall mention that I, on the 23. of July 1902, caught a young plaice of scarcely 2 inches, on *Kriegers Flak* (9—10 fathoms, Møens lighthouse in W. $^1/_2$ S., Mytilus bottom)."

Johs. Schmidt gives here a good picture of the occurrence of the fry of plaice in 1902 — a year which seems to have been favourable to the growth of this fry — and the picture becomes clearer when we look at the map, p. 8, where all the numbers of the stations at which this fry was found are marked with figures, while the places where the fry was not found in the time from June—Septbr. are marked with a 0. In 1902 we found no 0-group before June. In 1893 it was found already on the 30.



Where the fry of the plaice is found on the coasts in 1902 and 1893.

The numbers indicate where the fry has been found in June—September 1902,

o where the fry has been searched for but not found at the time mentioned.

——— The southern limit for the fry 1902.

——— - - — - - - 1893.

AXEL L. AARHOOT & LITH. ETABL. KBHVN

April near the mouth of the Limfjord in the Cattegat, but in small numbers only, and in the middle of May at Frederikshavn. In 1903 it was found at Esbjerg, by *A. C. Johansen*, already in the month of April; all these 4 places as very small fish, 1—2 ctm. in length, and it seems, consequently, that it appears on the shore a little earlier in the northern Cattegat and in the North-Sea than in the Belt-Sea. The small specimens at Schmidt's stations 4 & 7 show that we have here to do with quite recently transformed fish.

In order to give as much information as possible, also about the *quantity* or *frequency* of this fry at the stations that were investigated in 1902, I shall here give a copy of the journal kept by *Johs. Schmidt* on board the *Sallingsund*. The reader will then be able to judge for himself 1) of the time and labour bestowed on the investigation at the various places, also where no fry was found, and 2) through this, about the frequency of the fry.

"The Cattegat.

Saturday, June 14., 1902. (At Frederikshavn, at 2,45 o'clock). Out with the jolly-boat on the sand N. of the harbour to catch young plaice. With a shrimp-net with fine meshes several hundred were taken in the course of about half an hour. One haul of c 30 m. in length gave 63 specimens.

Wednesday, June 18., 1902. Caught fry of plaice on the sand S. of Asaa pier, in the morning, with a shrimp-net with fine meshes. There were not by far so many as at Frederikshavn; the greatest number we ever got in one haul was only 8.

Thursday, June 19., 1902. Tried to catch fry of plaice on the large plains of sand at the mouth of Mariager Fjord, but there was none at all.

At 11,15, at anchor off Hevringholm. From 11,30—12,30 we caught fry of plaice on the sand-banks along the shore; fine, clean, sandy bottom with fucus bushes. There were many plaice (as many as 12 in hauls of 30 meters), though not so many as at Frederikshavn. Besides the fry of the year we got here in the shrimp-net about 20 specimens of the I-group.

The Little Belt.

Tuesday, June 24., 1902. Fæno in Lillesund, at 5 p. m. With shrimp-net c. 100 were caught at Fænø N. of Espenhoved, mostly very small plaice.

Wednesday, June 25., 1902. Left Fænø at 6 a. m. Caught fry of plaice with shrimp-net on the sand-banks in Baaringvig. Found both plaice and flounders. There were here many plaice (c. 10 in one haul).

The Great Belt.

Kerteminde, at 5,30 p. m. Caught fry of plaice with shrimp-net on the sand, straight N. of the harbour. There were many plaice; 6 score in 20 minutes with a common shrimp-net.

Thursday, June 26., 1902. The little bay at *Slipshavn* (Nyborg) was searched with shrimp-net for fry of plaice. Only one plaice was found.

To Nyborg — — *Under Holckenhavn.* Investigated the fry of plaice with shrimp-net under Kajbjerg Skov, on the sand-banks. There were rather many young plaice (7 score in scarcely 1 hour, with 1 shrimp-net); but nearly all of them were smaller than at the other places where we have been this year.

Table II. **Fry of Plaice on the Shore 1902 (June—September).**

Millimeter.	Frederikshavn. 14. June.	Asaa Sand. 18. June.	Hevringholm. 19. June.	Fænø. 24. June.	Baaringvig. 24. June.	Kertemiude. 25. June.	Kajberg Skov. 26. June.	Fejø. 4. July.	Omø. 4. July.	Holckenhavn. 7. July.	Lundeborg. 15. July.	Thurø Rev. 15. July.	Lensskov. 15. July.	Drejø. 16. July.	Soby Bugt (Ærø). 16. July.	Vorbjerg (Ærø). 16. July.	Dyrehorg. 17. July.	Urehoved (Ærø). 17. July.	Bagenkop. 18. July.	Holmegaard (Langeland). 18. July.	Gottes Gabe (Laaland). 18. July.	Albuens Havn. 18. July.	Spodsbjerg. 19. July.	Hov Sand. 19. July.	Agerso. 21. July.	Glænø. 22. July.	Knudshoved (Smaalandshavet). 22. July.	Strandmøllen. 25. July.	Vedbæk. 25. July.	Nivaa. 26. July.	Julebæk. 26. July.	Skansehage (Isefj.) 31. July.	Sejrø. 1. Aug.	Holckenhavn. 21. Aug.	Lundeborg. 26. Aug.	Kertemiude. 28. Aug.	Hevringholm. 8. Sept.	Skansehage (Isefj.) 7. Sept.	Off Grenaa Harbour. 10. Sept.	Løgbøj (Mols). 10. Sept.	Maarup (Samsø.) 11. Sept.
Station:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
100	..	..	..	..	..			..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	2	1	..	.
95	..	..	..	..	..			..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	7	4	..	2	..	..
90	..	..	..	..	..			..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3	18	3	1	..	..	..
85	..	..	..	..	..			..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	4	13	5	..	1	..	1
80	..	..	..	..	..			..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3	2	19	7	1	..	..	1
75	..	..	..	..	..			..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	2	6	16	18	3	..	..	..
70	..	..	..	..	..			..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	3	15	12	33	5	..	..	1
65	..	..	..	..	..			..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	1	2	..	1	1	5	13	14	82	2	..	..	1
60	..	..	..	..	..			..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..	1	1	1	..	2	3	..	4	1	10	9	7	89	2	..	..	..
55	..	..	..	..	..			..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	2	1	2	..	..	1	..	6	..	3	..	21	1	11	66	3	..	1	..
50	..	2	..	..	..			1	..	..	5	14	..	..	..	..	1	..	..	..	..	1	3	1	1	..	..	3	3	4	..	6	2	24	5	4	22	3	..	..	2
45	..	2	..	..	..			..	..	..	2	15	..	..	..	..	..	..	..	..	..	1	11	2	3	..	..	1	..	2	1	5	..	8	..	2	6	2	..	3	..
40	1	23	..	2	10			1	6	1	2	19	..	2	7	..	2	2	1	..	1	1	14	1	2	..	..	..	1	3	..	10	1	7	..	..	..	..	..	..	..
35	7	19	4	..	51			5	13	3	8	5	13	1	4	3	1	12	3	..	1	..	1	13	6	3	..	..	..	..	1	1	3	..	4	..	..	..	..	..	..
30	35	16	54	2	30			7	3	2	9	3	4	3	7	2	..	9	1	..	2	1	1	1	14	1	1	..	..	..	..	1	2	..	..	..	..	..	..	..	..
25	58	8	57	1	2			10	..	..	10	1	2	..	3	1	1	1	..	..	2	..	1	..	3	..	1	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..
20	54	2	7	12	..			24	..	1	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
15	7	..	2	49	..			67	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
10	..	..	..	13	..			5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
5	..	..	..	..	..			..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Not measured. 120 specimens

The Baltic Sea.

Thursday, July 3., 1902. Left *Gedsergaard* at 8 a. m. Searched Rodsand E. of Vesterholm) with shrimp-net and bait-seine for fry of plaice; there were no young plaice.

The Great Belt.

Friday, July 4., 1902. We investigated the fry of plaice with shrimp-net on the sand-banks on the N. shore of Fejø. Found c. 30 plaice of the 0-group.

Searched the sand-banks on the east-side of *Omø*, S. of the telegraph mark, with shrimp-net for fry of plaice. There were a few plaice of the 0-group.

Monday, July 7., 1902. Searched the sands at the *bath-house of Holckenhavn* with shrimp-net for fry of plaice. In the course of 1 hour c. 30 plaice were caught.

Tuesday, July 15., 1902. Out at 8,35 a. m. Searched for fry of plaice with shrimp-net on low water:

1) S. of *Lundeborg*. We found here c. 5 specimens in each haul, both flounders and plaice of the 0-group.

The Southern Part of the Little Belt and the Western Part of the Baltic Sea.

2) *Thurø Rev.* Exceedingly many plaice of the 0-group (large, 1—2″).

3) *Iholm, Svendborg Sund.* No sandy bottom.

4) *Within Lensskov.* Very poor result. 5 plaice of the 0-group. In Faaborg at 4 o'clock p. m.

Wednesday, July 16., 1902. Left Faaborg at 6 a. m. Investigated the fry of plaice with shrimp-net on low water:

1) *Drejø.* In the course of $1^1/_2$ hour we caught with 2 shrimp-nets c. 20 plaice (c. 1″). Moreover a few plaice of the I-group were caught.

2) *Urehoved* (Ærø), on the N. E. side. In a little more than half an hour we caught with 2 shrimp-nets only 6 plaice of the fry of the year.

3) *Sæby Bugt* (Ærø). Good sand-banks. Not many plaice of the 0-group, though more than at Urehoved. C. 12 specimens in 20 minutes.

4) *Vorbjerg* (W. shore of Ærø). The shore too steep for wading. Tried to row with the shrimp-net on one fathom of water and got in the course of about a quarter of an hour two plaice of the 0-group.

Friday, July 18., 1902. Yesterday evening, wading with shrimp-net, we investigated the fry of plaice on the large flat sand-banks *W. of Dyreborg*. With 1 net we caught c. 30 plaice in 20 minutes.

Fry of plaice with shrimp-net: off *St. Albani Churchyard*, on the W. shore of Ærø. The shore was too steep for wading. A very small area was flat, and here we made a few hauls, but found no plaice.

Marstal Sande at Langholm. There were here large flat sand-banks with clean sand and fresh water, consequently seemingly good conditions for the fry of plaice. Nevertheless not one young plaice of the 0-group was found, though we fished for about one hour.

At Bagenkop, 1 o'clock p. m. Searched some sand-banks N. of Bagenkop harbour with shrimp-net. Found, in 20 minutes, only 2 young plaice (0-group).

Off *Holmegaard* (Langelandsbæltet). Looked for fry of plaice with shrimp-net. The shore too steep for wading, Fine sandy bottom. Fished with shrimp-net from the jolly-boat. In the course of half an hour we got 4 plaice of the 0-group.

Gottesgabe (S. Laaland). Looked for fry of plaice. The shore was also here too steep for wading. With shrimp-net from the jolly-boat we found in half an hour 2 plaice of the 0-group.

Albuens Havn. Investigated the fry of plaice with shrimp-net. There were

no real sand-banks, but just on the edge of the sea-shore there was a narrow belt of gravelly sand where we could wade. In the course of about 1 hour we found c. 6 plaice of the 0-group.

The Great Belt.

Saturday, July 19., 1902. Investigated the fry of plaice with shrimp-nets:

1) On the sands south of *Spodsbjerg*. Good sand-banks. There were here *exceedingly many plaice;* in 10 minutes we got c. 50 with 1 shrimp-net (c. 20 in one haul of 15 meter).

2) At *Hov Sand*. Less good bottom; nevertheless c. 5—6 in short hauls. In the course of half an hour c. 30 plaice of the 0-group.

Monday, July 21., 1902. Investigated the fry of plaice on the east-side of Agersø. Good sand-banks. In the course of 20 min., 13 plaice with one net, all of the 0-group.

Tuesday, July 22., 1902. Investigated the fry of plaice with shrimp-net off:

1) *Glænø Vesterfed*. Good sand-banks. In the course of about half an hour we caught, with one net, only 1 plaice of the 0-group.

2) *Gumperup Klint*. Wading impossible. No plaice; but the investigation was difficult on account of the steep shore.

S. of Zealand.

3) The south-side of *Draget Knudshoved*. Owing to high water only a very small area with good sand-banks could be investigated. In a good half-hour, with 1 net, 1 plaice (2″) of the 0-group.

4) E. of *Orehoved* ferry-harbour there were no sand-banks.

5) *Masnedø Kalv*. No sand-banks.

6) *Lilleø* (between this and Tærø). Flat areas with sand-mixed gravel and spots of characeæ. No fry of plaice.

7) *Koster*, E. of the ferry-harbour. Gravelly sand. No plaice.

8) Off *Farnæs* forest. Gravelly sand with characeæ. No plaice.

The Baltic Sea proper.

Wednesday, July 23., 1902. Left Stubbekjøbing at 7 o'cl. a. m. Looked for fry of plaice with shrimp-net:

1) Just W. of *Stubbekjøbing* harbour-mole, on pretty good sandy bottom. No fry of plaice.

2) At *Grønsunds Hage*. No sand-banks.

3) Off *Næsgaard*. There were here several good sand-banks. We fished for half an hour, but found no plaice.

4) W. of *Klintholm* harbour (Møen). Splendid large sand-banks in fresh water. Investigated the inmost bank for half an hour with shrimp-net, but found no plaice.

Thursday, July 24., 1902. Investigated the fry of plaice with shrimp-net:

1) On the east-side of *Ulfshage* (Sohunde harbour). There were splendid large sand-banks. In 15 min., with 1 net, we found no plaice.

2) South of the leading lights on *Præstø Fed*. Splendid sand-banks. In 20 min. we caught no plaice.

3) N. of *Faxe* harbour (the northmost). Good sand-banks. In 15 min., with 1 net, we caught no plaice.

4) At *Kjøge Sønakke*. On most sand-banks the water was too deep for wading. With shrimp-net from jolly-boat, and wading with shrimp-net on a little sand-bank, we caught 1 turbot and 1 flounder.

We also tried at *Stevns*, N. of the lighthouse, but the water was here too

deep for wading; we then tried a haul with bait-seine, but got only some gobies.

Friday, July 25., 1902. Left Kjoge at 6 a. m. Investigated the fry of plaice with shrimp-net:

1) On the east-side of *Aflandshage* (Amager). No proper sand-banks with low water suitable for wading. With shrimp-net we caught from the jolly-boat, on somewhat deeper water, a couple of flounders.

The Sound.

2) North of *Kastrup* harbour (Amager). Nothing was found.

3) Just N. of *Strandmøllen* (in the Sound). The water was here too deep for wading on the banks, but with the shrimp-net from the jolly-boat we caught in 20 min. 5 plaice of the 0-group.

4) Off *Sophiehøj* (N. of *Vedbæk*). There were here pretty good sand-banks on which we could wade. With 1 net we caught in 25 min. 7 plaice of the 0-group.

Saturday, July 26., 1902. From Elsinore at 8 a. m. Investigated the fry of plaice with shrimp-net:

1) N. of *Nivaa* brick-works. Good sand-banks. With 1 net in 20 min. 23 plaice of the 0-group.

2) Off *Julebæk* forest. Good sand-banks. With 1 net in 15 min. 3 plaice of the 0-group.

The Isefjord.

Wednesday, July 30., 1902. From Elsinore at 6 a. m. Investigated the *fry of plaice* in *Roskildefjord* with shrimp-net:

1) At *Øxneholm*. No fry of plaice was found.

2) *Dyrencæs Hage*. Good sand-banks. No fry of plaice.

3) N. and S. of *Frederiksværk*. Good sand-banks No fry of plaice.

Thursday, July 31, 1902. Left Frederiksværk at 7,30. Investigated:

1) *Hønsehalsen*. Good sand-banks. No fry of plaice.

2) *Holkerup*. Good sand-banks. No fry of plaice.

3) *Skansehage* (off the hospital). Good sand-banks. In 20 min. we caught c. 40 plaice of the 0-group

The Great Belt.

Friday, August 1., 1902. Left Nykjøbing at 5,15 a. m. Investigated the fry of plaice with shrimp-nets on the north-side of *Sejrø* off Kongshøj. The breakers on the lowest sand-banks made wading impossible. We worked for half an hour with the net from the jolly-boat and caught 5 plaice of the 0-group.

Tuesday, August 26., 1902.

The 0-group of the plaice is found on the sand-banks on low water *S. of Lundeborg.*

A number of plaice, which must be supposed to be *one year old*, were found off Lundeborg, most of them on deep water (9 fathoms), on the oozy bottom, together with common dabs; a few also on the sand-banks on low water. Such plaice, then, seem here (and in Nyborg Fjord) to live under very different conditions.

Thursdag, August 28., 1902. North of Kjerteminde harbour on 2 fathoms of water: I. A number of plaice of the 0-group were taken on the sandy bottom with shrimp-net. — II. With bait-seines we made some hauls towards land. Of flat-fishes (plaice and flounders) we took altogether 8 score (2 score in the haul).

The Baltic Sea proper.

Thursday, Septbr. 4., 1902. Left Gedser at 5 a. m. Investigated the sea-shore off *Bøtø-Gaard* for fry of plaice, wading with shrimp-nets. 2 hauls with inch-seine[1]); one of them gave — 1 plaice, 3 inches long.

The Isefjord.

Saturday, Septbr. 6., 1902. At anchor off *Skansehage*, at 8,30: Fished with shrimp-net on the shore, and with inch-seine. A few plaice were found on the sands on the shore.

The Cattegat.

Monday, Septbr. 8., 1902. Off *Rygaarde* and *Hevringholm*. Investigated the sand, from 1—6 feet, with inch-seine, bait-seine, and shrimp-net. Got many plaice of the 0-group and not a few of the I-group.

Wednesday, Septbr. 10., 1902. Fished north of *Grenaa* harbour from 6 till 7,15 a. m. with shrimp-net and inch-seine. 4 hauls with inch-seine from c. 1 to c. 8 feet: 4 plaice.

Off *Gaasehage (Helgenæs)*. Tried with a shrimp-net to find plaice on the sand-banks. There was none.

The Belt-Sea.

Off *Løgbøj, Mols*. Looked for plaice on the sand, with shrimp-net. Caught in a short time 4 plaice.

Thursday, Septbr. 11., 1902. Off *Maarup in Samsø*. Only very small spots of sand free from stone (on the sea-shore). 2 hauls with inch-seine from c. 2 to 8 feet. 6 plaice."

For 1903 we have, from Denmark, no such detailed investigations into the distribution of the fry of plaice as we have from 1902; but the fry has been seen as far down as the southern end of the Great Belt, and when we compare this with the results of the German investigations, the limits for the occurrence of the fry must be supposed to have been about the same as in 1902. At Bornholm I found no 0-group at all, in spite of thorough investigation. *Ehrenbaum*, in 1903, found the 0-group at Eckernførde, and *Krüger* in Kielerfjord (Laböe), Travemünde, Warnemünde, *but not at Rügen (Barhöft)*.

In 1893, as will be seen from "Report of the Danish Biological Station, IV", page 10, the occurrence of the fry in the Cattegat and along the shores of Funen and Zealand as far as Bornholm was investigated at some 50—60 stations. If we draw a line from Vejle in Jutland to the northmost point of Langeland and from this place to Copenhagen (cmp. the map, p. 8), all the stations where the fry occurred in large numbers are situated north of this line. On the western shores of Funen it was very scarce, and was found at one station only, although there are 3 stations here. At Fænø in the Little Belt there was none; on the eastern shore of Falster we found one, 2 inches long; and at Kjøge, in East Zealand, on the 16. of August, we found two, $3^1/_4$—$3^1/_2$ inches. At Bornholm we caught three, in September, 2—$2^3/_4$ inches long (l. c. 105—108); *Apstein*, however, did not

[1]) i. e. a seine the meshes of which are 1 inch from knot to knot.

find any at Eckernförde in August; on the other hand he caught 153 flounders. *In 1893, the southern limit of the distribution of the fry, in June—September, seems consequently to have been more to the north than in 1902.* The shores of Laaland, Falster, and Møen were investigated with particular care in 1893, but we took here altogether only one specimen. In spite of eager investigation at Kerteminde, where the "Biol. Station" was situated, the fry of plaice was not found here on the sands till 1. June 1893, and then already mixed with flounders as small as 8 mm in length.

These two years, 1903 & 1893, are those in which we made the most detailed investigations. Of other years I shall give the following information.

In 1901 Dr. *Th. Mortensen* investigated Bornholm from June 26.—July 6., without finding any specimen of the 0-group.

In 1900, in June & July, the fry was found in the northern part of the Cattegat and in the mouth of the Isefjord; at the latter place only in small numbers. At Samsø only a few were found, and at Reersø in the northern part of the Great Belt, in spite of eager investigation, only 2 specimens. At Laaland, in spite of eager investigation, we found none. I still remember, distinctly, my astonishment at finding so few young fish that year, as I had formerly caught many more in the Belt-Sea. I was particularly desirous that year of pointing out where to look for the *head-quarters of the southern race with the smaller number of rays in the fins*, but wrote in my journal on board S. S. *Sallingsund*, the 21. of June, 1900: "The result of our search for the 0-group this year seems then to be that such fry is very scarce this year in the Great Belt and around Sejrø, though there is a little everywhere, where there are the necessary natural conditions. The head-quarters of the fry of the southern race must therefore, for the present, be supposed to be on the eastern shores of North-Zealand and Middle-Jutland."

This year, therefore, seems to have resembled 1893 in this respect that the fry only proceeded a short distance towards the south in the Belt-Sea.

I have through these investigations got the decided impression that the fry in the Belt-Sea is never so numerous as in the northern Cattegat, and that its geographical distribution down there varies very much from year to year.

We may be quite sure, however, that the fry of plaice of the 0-group is found every year on the western shore of Jutland (in large numbers at Esbjerg and Thyborøn); on the shores of the Cattegat towards west and south (of Sweden nothing is known); and a longer or shorter distance down into the Belt-Sea, sometimes as far down as the western part of the Baltic Sea, west of Laaland and Femern, but *only on the more open shores and at the mouths of the fjords, never deep into the Limfjord or the Isefjord.*

It is also most likely that the fry is not found in larger numbers, but only singly, and *especially towards autumn when it has grown a little larger,* in the seas east of Gedser—Darserort; but, certainly, from Germany we

have here only very few direct investigations, and from Sweden none at all. It would be of great importance to get such in 1904 and the following years.

I presume, however, that such investigations from other countries will give results similar to the above mentioned, and several German investigators, *Schiemenz*, *Ehrenbaum*, and *Strodtmann* seem to have the same opinion. But this must be confirmed by direct investigations carried on through several years; and we must not be content with looking for the fry along the shores in localities similar to those where it usually occurs. It is possible that the fry can live and develop itself on deeper water, as, for instance, the fry of the common dab *usually* does. Certainly, I do not believe this to be the case; but we must be able to say that this possibility is excluded by our direct investigations, as it is now, in my opinion, in the Danish seas proper.

What are the Causes of the peculiar Distribution of the Fry?

We all know that the plaice have *pelagic* eggs, and that the young fish go through their transformation from young ones, c. 6—7 mm long, just out of the eggs, till they become unsymmetrical when they are about 11—14 mm, and then go to live on the flat, sandy, sunny shores. As above mentioned this takes place within the Skaw, in the months of May and June. The eggs, on the other hand, are shed from November (October, *Trybom*) till some time in April; but most of them, certainly, in the depth of winter ("Report of the Biol. Station, IV"). We know now, from earlier times (*Hensen*, *Petersen*), these eggs with embryos from all open seas within the Skaw as far down as into the western part of the Baltic Sea; and *Petersen* has them from the Baltic Sea in large numbers, south of Møen, in March 1902 and Februar 27.—28., 1903, on 12 fathoms' depth, with a salinity of 17,4 $^0/_{00}$ and 2,5° C. March 21., 1903, we searched for eggs again in the same place, but now the salinity was only 10,6 $^0/_{00}$, temp. 3,8° C., and no eggs were found. In February we had had violent western storms, therefore, probably, the salt water; the latter together with the eggs disappeared, however, in the course of March. On the expedition of the *Poseidon*, in February 1903, eggs were also taken in large numbers in the western part of the Baltic Sea, decreasing, considerably, in number towards Bornholm; one is even stated to have been taken east of Bornholm, where the salinity was only 13,73 $^0/_{00}$ on the bottom.

In all these seas we may also take plaice with ripe spawn and milt; south of Møen I have caught them many times in huge multitudes, and *Trybom* ("Svenska hydrogr. biol. Kommissionens Skrifter I", p. 10) found

them near Bornholm. There is no reason to doubt then that the plaice produce fecundated eggs as far east as Bornholm, and perhaps still farther; nor did anybody ever doubt it. But the question is: *What becomes of these eggs?* Do they die away? Do they drift away? *For of the huge multitudes no corresponding quantities of fry remain in the Baltic Sea proper; at any rate not of fry that has passed through all the pelagic stages, and stay near the bottom.*

Of pelagic young plaice only very few have hitherto been found east of Gedser. The *Poseidon's* three expeditions in 1903 gave only 18 in the Baltic Sea, against more than 200 flounders and common dabs together, and personally I have, in 1903, found only very few pelagic plaice, but as well east as west of Gedser. To throw more light on the quantity of these larvæ, these investigations, therefore, must be continued in March—May with suitable apparatus; the common pelagic nets are not well adapted for the purpose. A *youngfish-trawl* which I have constructed and employed already for several years from the *Sallingsund*, has a far greater fishing-capacity. Dr. *Johs. Schmidt*, who employed it with great profit in Iceland, 1903, will in another work give a description and a picture of it. I shall here mention only, that it is a sort of small otter-trawl made of cheese-cloth or "stramin", whatever you will call it, and may be employed on somewhat deeper water, in the very mass of water as well as near the bottom, to catch the fry belonging to the bottom-stage.[1])

On the whole, there seems to be, in the pelagic life of the plaice, something which has hitherto remained unexplained. Its larger pelagic fry has been found nowhere in very great numbers, not even near Iceland where young *gadoids* and other *pleuronectids* have been taken in multitudes. Yet we should suppose it must have a long pelagic existence, since the eggs occur in the Baltic Sea already before the beginning of winter, while the little young ones belonging to the bottom-stages are not to be found till the end of spring.

Owing to this circumstance we cannot very well, at the present stage of our knowledge, use the few finds of the pelagic fry of the plaice in the Baltic Sea for quantitative determinations; for this purpose *we had better use the bottom-stages (the 0-group)*, as they are found in great numbers in many places, and as it is easy to catch them and determine them.

We do not know at all, for instance, if the 0-group which occurs in the Baltic Sea in June, comes from eggs that are shed in the Baltic Sea.

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[1]) As to the fishing-capacity of this youngfish-trawl I shall say only that, west of Ærø, in the western part of the Baltic Sea, on 20 fathoms of water, May 15., 1902, on soft clay bottom, I caught in one haul which lasted 10 minutes, more than 1000 young ones of *Lumpenus lampetriformis*, between $^1/_2$—2 inches long, as also several hundred of two larger groups, respectively 3—$5^1/_2$ inches and $5^1/_2$—8 inches long, besides some still larger specimens. I had not known before that this fish is *one of the commonest* on deeper water in the western part of the Baltic Sea.

There are people, perhaps, who have no doubt about it; but I cannot help doubting, and I regret that I have not formerly been as consistent in my doubt also with respect to the Cattegat, a fact to which *Ehrenbaum and Strodtmann*, l. c. page 123, justly call attention. For it is quite possible, indeed, that the Cattegat does not get its main supply of young plaice through fry of its own eggs, but that the greater part of the fry, perhaps, comes from eggs shed in the North-Sea, the Baltic, or the Belt-Sea.

For one thing is certain, that the eggs in the long period before the hatching, and the fry in the still longer pelagic period (from October till May—June, as we may suppose for many of them), must be carried along with the current — in most cases we scarcely know where. According to my earlier investigations the eggs have such a specific gravity that they can only float in water which at 10° C. has a salinity of 14,4 ‰, or higher. *Hensen* has found that somewhat higher salinities are necessary. But in open nature I have often found eggs of plaice in water of c. 15 ‰, and *Ehrenbaum*, l. c., thinks he has found such an egg at a salinity of 13,73 ‰ and a temperature of 4,57°; I do not, however, attach great importance to this one egg. By my experiments I have shown ("Report of the Biol. Station, IV") that there is a considerable variation in the floating-power of the eggs; but as a rule they will scarcely be found, I think, in water of a salinity lower than c. 14,5 ‰. They are able to float, consequently, only where there is such water, and if they cannot float, I must suppose that they die; for it is not very likely that they can be developed in the oozy particles of the bottom, and if they only touch the latter, they will probably be devoured in the course of a very short time by the animals that live there.

The existence and development of the eggs is, consequently, only possible, where there is for some length of time water of a salinity of c. 14,5 ‰, or higher. We do not know more exactly what salinity the pelagic young fish require, what temperature, light etc.; but the very necessity of a salinity of a least 14,5 ‰, through rather a long time, reduces the distribution of the eggs considerably.

I have before me a map of the Danish seas on which a number of places have been marked down where pelagic eggs were not found at all in the surface in March & April 1902, and other places where they *were* found. These places, altogether c. 20, have been stated by Lieutenant *C. J. Hansen*, R. N., a gentleman whose name is often mentioned, e. g. in "Report of the Biol. Station, IV". While in command of the schooner *Argus*, he fished for pelagic eggs with a silk net of the usual form and size, in the Belt-Sea, in the above mentioned months. If we draw on this map a line from Cape Kullen to the southern point of Langeland, all the stations where eggs have been caught fall north and west of this line; no eggs have been caught south and east of the same. All these eggs were taken in the surface. The said line is very nearly identical with the boundary line between water of 10—14 ‰ salinity and water of 14—21 ‰ or higher salinity,

measured by aræometer on board the *Argus;* in fresher water no eggs are to be found, in the more saline water they are found as it were always. Doubtless, these eggs are not all eggs of plaice, but at several stations they certainly are, according to my later determinations, and at any rate all the negative results give certain information. Another map which lies before me, based on our own investigations, in March 1902, into the occurrence of eggs in the lower strata of water, shows, on the other hand, that eggs of plaice are found in the deep water everywhere in the Belts as well as in the eastern part of the Baltic Sea, as far as S. E. of Møen, *under the overlying fresher strata.* But these deeper masses of water do not, as a rule, reach the shores, and they do so more and more rarely the farther south and east we go through the Belts into the Baltic Sea.

It is not my opinion that the line Cape Kullen—the Southern Point of Langeland is constantly the boundary between the salinities of c. $14{,}5\ ^0/_{00}$ and the lower ones. The line may go up or down, particularly the south-western part of it (cmp. the fine maps of salinities in the publications of "Kom. til vidensk. Undersøgelse af de danske Farvande"); but it marks the territory near which we must look for this boundary line, and indicates roughly the southern boundary of the territory where the fry of plaice belonging to the bottom-stage is generally found in large numbers on the shores (cmp. map. I, page 8).

In the present state of things we must suppose, therefore, that the eggs of plaice, which are found in the sea, presumedly, from the Skaw down into the Baltic as far as Bornholm, as a rule, can go through all pelagic stages to the bottom-stage, *only where the water at certain times can lift them up in the vicinity of the shores and thus carry the young fish to the low, light, sunshiny, and warm coasts which seem to be necessary for their development, while those which remain in the dark, cold, low strata of the water in the Baltic Sea proper, evidently, as a rule, are destroyed.*

A close study, through several years, of the occurrence of the tender fry on the shores, compared with the changing hydrographic conditions, will therefore, no doubt, give very interesting information with respect to the growth of the stock in the various years.

What may be concluded from the Distribution of the Fry with respect to the Renewal of the Stock?

In the Cattegat, from the Skaw to a little south of Anholt, about 10—15 million plaice are caught yearly. In the sea north of Zealand and around Samsø as far down as north of Funen only a comparatively small number of plaice is caught; for some reason or other the plaice is less common in these parts. In the sea around Funen down to Femern, on the other hand, some more are caught, presumedly a few million plaice yearly, of more or less

good quality and size. In the Baltic Sea proper, between Møen and Rügen, a few millions have been caught of late years, of a peculiarly small, but numerous form, so small that its market-value is but very little. From these parts eastwards the plaice evidently decreases very much in number; but *Schiemenz* has found it east of Gothland at the eastmost of the stations investigated, and it is found, although sparsely, as far up as Stockholm, mostly, I presume, on the deep. The places within the Skaw where I have caught most plaice in the shortest time, are the seas between Rügen, Schonen, and Møen. Their numerousness here can be compared only to that of the young plaice (the II and III-group) at Thyborøn in the western part of the Limfjord or at Horns Rev near Esbjerg. At Møen, on the other hand, we catch, as I have said, almost exclusively grown-up fish. I shall not here enter into the particulars as to the age, growth, and "races" of the plaice; they will be given, most likely, in a later publication by one of my co-workers. One thing only I shall mention: that a numerous and widely distributed stock of grown-up fish is living east of Gedser (cmp. table I, column III), and this though the 0-group is so rare in these very seas, that, in spite of all our searching, only c. 50 specimens that may be assigned to this group, were taken through many years together, against thousands in our other seas. The following group (I) is also scarce (cmp. table I, column III), though perhaps not equally scarce every year (See "Report of the Biol. Station, IV", table VII, column 10).

We can imagine this large stock in the Baltic Sea to be renewed in 3 ways only: either 1) exceedingly *slowly*, by a very slight, annual propagation, or 2) by a large propagation *in certain years*, in which the hydrographic conditions then must be very different from the usual, and the fry occur in large multitudes, or 3) by *immigration*. In the first case the plaice must be very old in the Baltic Sea, of which their otoliths perhaps might give us information. The researches have as yet never indicated anything about a numerous fry in certain years, and this possibility is most probably excluded, already from a hydrographical point of view. The only hypothesis remaining is then that of immigration, which *Schiemenz* as well as *Ehrenbaum* and *Strodtmann* seem inclined also to adopt. It must then especially be the I-group that immigrated from the Belt-Sea to the western part of the Baltic. The bodily differences between the plaice in these seas may very well agree with such a hypothesis. But this immigration must be elucidated by renewed investigations into the occurrence of the fry, particularly in the southern part of the Great Belt and along the German shores of the western part of the Baltic Sea; for in this I fully agree with *Ehrenbaum* that the fry must come either from the Belt-Sea or from the western part of the Baltic, scarcely from the Cattegat properly so called.

Some General Remarks on the Distribution of Various Species of Fish, as Fry and as Grown-up Fish.

That the *eel* passes certain periods of its life in fresh water, or in sheltered seas in salt water, without breeding there, for instance, in the whole of the Baltic Sea, and therefore must undertake long migrations to go through the remaining part of its life; that it has, in short, a quite different geographical distribution in the different periods of its life, is now granted, I think, by most people. That something like this holds good also of many other fishes, has long been known; the salmon breeds in fresh water, and lives at other times in the sea far from its native place. These migrations have been termed breeding-migrations, and they have been compared to those of the migratory birds which we all know. By little and little the fact of these migrations has become generally accepted. But we have had great difficulty in reconciling ourselves to the thought that a fish like the *plaice* should not go through its whole development everywhere, where the grown-up plaice are found. And yet we know that the *flounder* often lives in fresh water and gets ripe eggs, although it cannot breed there *so that any fry will come out of the eggs.* Now, it is no doubt the rule that the flounder tries to emigrate to the sea in order to shed; but it is often prevented from so doing by natural hindrances, artificial dams, or such like, which the small fry from the sea may be able to penetrate perhaps, but which are impassable to the grown-up fish. We have here then, close at hand, an example which reminds us of the plaice in the Baltic Sea. And how can we expect, after all, that animals requiring such different conditions of life, as the young plaice on warm sunshiny shores and the grown-up fish which prefer darkness and cold water on the deep, should have the same geographical distribution? Is it strange that the fry stops somewhat earlier on the long and winding way from the Cattegat into the Baltic Sea, than the grown-up fish? Evidently, however, it is not this either which has appeared so inapprehensible to many people; rather the fact that *the plaice of the Baltic Sea does not emigrate every year to shed its spawn at more favourable places,* i. e. places where the eggs can be developed into fry. Such an inexpediency seems to many inapprehensible. To be sure, if all plaice were as unfortunately situated, it would, evidently, be inapprehensible, if not the eggs, after all, were carried away by the current to more favourable places, but of this last, however, we know as yet nothing positive. I believe this way of thinking is a remnant of old learning which was good philosophy perhaps in its own time; but if we want to understand the natural conditions as they really are, we had better guard against such preconceived opinions. Botanists, for instance, know several examples of a huge wasting of propagative products in nature. Several Phanerogams are distributed in such a way that through large regions one sex is found only, the other not; the plants are then reduced to vegetative reproduction,

and their flowers are of no use for the propagation. Why must then al eggs of plaice be shed under favourable conditions? After all, we have always thought that only a very small number of them, on the whole, become grown-up fish, even under the most favourable circumstances. To my thinking, there is nothing to prevent us from accepting the facts we obtain by our investigations in nature, even though they go greatly against what we usually call "expediency". If the eggs of the plaice cannot be developed in one sea, then the stock will die out, by little and little, if not an immigration takes place from somewhere else. If it does not take place the stock is lost; this, in my opinion, is all the expediency that is found in nature.

It is not only in the Baltic Sea, however, that the fry of the plaice belonging to the first bottom-stages has another geographical distribution than the grown-up fish. I dare say, this is the case in nearly all places where the plaice lives, for instance in the North-Sea. Here the fry is found only on a quite narrow strip along the shore, on low water, while the central parts of the North-Sea are peopled by the older fish only. Consequently, the plaice cannot live its whole life out here either, and only the eggs and young fish which come near the shore at the right time can be developed. We do not know how great a part of the whole number of eggs and pelagic young fish is condemned to death from the beginning, because they have got into unfavourable currents which do not carry them landwards; but we have no right to doubt that many are destroyed before they are developed, already on account of the hydrographical conditions. If this is the state of things in the particular home of the plaice, the North-Sea, why should it not be highly probable that still greater difficulties arise, which may prevent the development of the eggs, where the fish is near the limits of its distribution, for instance in the Baltic Sea, where, moreover, the conditions as to salinity make matters very complicated indeed. There must be something which attaches the plaice to the area within which they are actually distributed, or rather, there must be something which prevents the plaice from passing the limits of this area; otherwise such limits would not exist. Nothing seems to me more probable then, than that it is the grown-up fish, especially, which can best try to pass these limits and which actually also do so, but that the tender fry is stopped by the difficulties, for instance, the differences in the physical conditions. I do not see, therefore, that there is anything to prevent us from supposing, that the full-grown and half-grown plaice very well can live in the Baltic Sea, and that the eggs can be shed there, but that the latter cannot go through their whole development everywhere, where they are shed, when the results of the investigations, in point of fact, lead to this supposition. To speak of "die innere Unwahrscheinlichkeit von dieser Annahme" seems to me to be quite groundless.

That the fry and the grown-up fish of many species have not always

the same geographical distribution seems to become noticed and admitted with respect to more and more species; I shall only mention that *Ehrenbaum* in his last beautiful work on "Fische mit festsitzenden Eiern. Wissenschaftl. Meeresunters. VI, 1904", says that the sea-wolf (*Anarrhichas*) certainly is found at Heligoland, but whether it "überhaupt in der Deutschen Bucht laicht, darf bezweifelt werden".

What ought to be the Particular Object of Future International Investigations?

To examine closely whence the stock of plaice within the Skaw more particularly gets its increase of young fish, we must study 1) where the spawning fish are to be met with in multitudes; 2) where their eggs are to be found in the greatest numbers; 3) where the pelagic larvæ, and 4) where and when the young fish belonging to the bottom-stages appear on the shores. I shall not discuss here more closely how this can best be done; I only wish to say a few words as to the investigation of the bottom-stage.

From table II, page 10, it is seen that quite small young fish are found at Fænø, station 4; at Nyborg in the Great Belt, station 7; and partly at Frederikshavn, station 1. They have been taken as small as 10 mm. When we find them so small, we can be pretty sure that they come from pelagic fry *which has lived through its last stages in the neighbouring seas.* But often the fry is not found till later in summer or in autumn, and then it is considerably larger (table II, page 10); in September a few specimens reach 10 ctm. *The current along the shore can now very well have carried the fry far away from the places where it lived as pelagic fry.* When we have seen the fry penetrate into the Limfjord, from west to east, or when we have seen what the strong currents in the Belts can carry along of pipe-fish, gobies, eels, remmants of plants, small stones, etc., we will understand to value this momentum. *The younger we find the 0-group, the more certain, therefore, we may be, that we are near the places where the pelagic young fish have lived.* At any rate we must take care to keep the 0-group apart from the 1-group, and we do this in the safest way by measuring the fry. How much help we may get here by examining the otoliths, I do not know; *Apstein's* results, loc. cit., do not seem to me to be very probable, and at any rate they must be supported by measurements if we shall be able to say anything positive. I shall only point out the fact that the quite tender fry has not been found in the Baltic Sea properly so called and at Bornholm; as a rule the young fish found here are more than 3 ctm. I should very much wish to know if they are to be found here in the first stages, immediately after their transformation. Therefore we must carry out our investigations in May or June with a shrimp-net of a fabric which is so closely woven that the holes just permit the necessary sand to pass

through; for plaice 10 mm long are very slender, and can go through any net knit with a needle like a common fishing-net.

I have here mentioned which purely biological conditions it would be of interest to have investigated with respect to the fry and eggs of the plaice. But it is another question whether we have not here entered a field of research which, by a very intimate co-operation of biologists and hydrographers, might give us a greater and deeper understanding of these matters. By a minute study of the specific gravity of the eggs under different pressures and different temperatures, together with a close study of the movement of the masses of water, particularly with a view to the occurrence of the eggs, we must be able to get more information; and so I leave this matter to both hydrographers and biologists for further consideration.

II.

On the Young Stages of the genus *Zeugopterus*.

By C. G. Joh. Petersen.

(With one Plate.)

Preface.

Though the genus *Zeugopterus* is of little consequence in practical fishery, and only one species, the megrim (*Z. megastoma*), has any market-value, it is not without use to know its fry; if for no other reason, in order not to mistake it for that of other common flatfishes, and thus draw wrong conclusions as to the occurrence of the latter. The determination of the fry of these fishes has already caused much difficulty. Through the kindness of Professor *R. Collett*, of Christiania, and Dr. *E. W. L. Holt*, of Dublin, who have sent me material for which I beg to express my best thanks, it has been possible for me to remove some of these difficulties, by studying this material in connection with what has been gathered by the Danish Biological Station and the *Thor*. I have thought it proper, therefore, to publish these investigations, though I do not yet know the young of the southmost species, *Z. unimaculatus*, but only of the four other species: the three which are found in Denmark, *Z. norvegicus*, *Z. punctatus*, and *Z. megastoma*, and the fourth, *Z. boscii* which, besides elsewhere, lives also near England.

In 1893 *E. W. L. Holt* in "Scient. Trans. Royal Dublin Society", vol. 5, ser. 2, table II, gave pictures of a series of sinistral flatfish, from c. 6—c. 10 mm in length, without any spines on the head, and with a peculiar development of the caudal fin (two are reproduced on my table I, fig. 6—7). In the same work, table 12, he gives pictures of 2 other young flatfish, evidently also belonging to a sinistral flatfish with a similar peculiar development of the caudal fin, but further characterised by a pair of large "otocystic" spines on either side of the head and by a peculiar, striped pigmentation on the fins and the interspinous bones (see my table I, fig. 1—3). These two types of young ones, the smooth type and the spiny

type, as I shall here call them, have afterwards always been easy to recognise; but to decide to which species one belongs, and to which the other, within the genus *Zeugopterus*, has hitherto caused great difficulties.

The genus *Zeugopterus*, in my opinion, includes the 5 species: *unimaculatus*, *punctatus*, *norvegicus*, *megastoma*, and *boscii*. In all these five the isthmus between the gill-cavities is perforated. *Holt* himself was in doubt to which of the two firstnamed species the smooth ones belonged; but he thought that the whole form of their body necessarily referred them to one of these two. With some doubt he then referred them to *Z. unimaculatus*, because his oldest specimen had more than 80 dorsal rays and more than 60 anal rays, and this number agreed best with the information he had found in literature with respect to *Z. unimaculatus*. As for the spiny young ones, then he hesitated between *Rhombus lævis* and *Zeugopterus norvegicus*. The number of fin-rays, c. 80 dorsal rays and c. 60 anal rays might very well refer them to the latter. The young ones of *Rhombus lævis* have been described afterwards by others, also by myself in "Report IV"; to compare these spiny young fish with them is quite out of the question.

In "J. M. B. A." (N. S.), vol. III, 1893--95, p. 202—205, *J. T. Cunningham* describes some spiny young sinistral flatfish, from Plymouth, which very nearly agree with those described by *Holt*. They have as many as 90 dorsal rays and 69 anal rays, and in his opinion, therefore, their parents cannot be *Z. norvegicus*. He refers them to *Z. punctatus*, which has a larger number of fin-rays. Of the smooth young flatfish he gives no particulars.

M'Intosh has on various occasions described and mentioned young flatfishes, both of the smooth and of the spiny type. In his last work, "British Marine Food-Fishes", 1897, he comes to the result that the smooth forms belong to *Z. punctatus*, the spiny ones to *Z norvegicus*. One of his arguments is that *Z. unimaculatus* has not been found on the eastern shores of Scotland; another, and a more essential one perhaps, is, that he has found that the dorsal fin of the smooth type may number as many as 89 rays and the anal fin as many as 64 ("10. Ann. Report F. B. for Scotland", 1891, p. 277). In this respect, consequently, he meets the same difficulties by referring the thorny type, with 90 and 69 rays, to *Z. norvegicus*, as by referring the smooth one to the same. He is freer, therefore, in his choice between *Z. norvegicus* and *Z. punctatus* than *Holt* is, and therefore refers the smooth young ones to the latter, which, in his opinion, they resemble most in the form of the body, and the spiny ones to *Z. norvegicus* which is more like these. *Holt*, at first, also thought this to be the correct determination of the spiny young ones. *Z. unimaculatus* is considered by *M'Intosh* to be excluded, because, as above mentioned, it has not been found on the eastern shores of Scotland.

In "J. M. B. A." (N. S.), vol V, 1897—99, p. 128—135, however, *Holt* again discusses this question, and is of opinion that *Cunningham* has proved

that the spiny larvæ belong to *Z. punctatus*, probably because they have a large number of rays, and he is not convinced by M'Intosh's arguments. *Holt*, consequently, gives up his original opinion, that the spiny larva should be the young of *Z. norvegicus*, and refers it to *Z. punctatus* on the strength of *Cunningham's* investigations. He does not venture, however, to speak with any greater decision about this matter.

As will be seen from the above, the number of fin-rays has been of great importance in the whole argumentation as to the determination of these larvæ[1]). In itself it is a dangerous thing to rely too much upon the number of fin-rays; firstly, because only a very small number of specimens of these species has been examined, and, secondly, because the number of rays in these fishes varies not a little.

Lilljeborg states for *Z. punctatus:* d. 87—101; a. 80—69; vertebræ 36—37,
Z. megastoma: d. 91—85; a. 75—61; » 41,
Z. norvegicus: d. 84—79; a. 67—58; » 34—35[2]),
Z. unimaculatus: d. 80—70; a. 68—61.

It will be seen that there is here a great variation within the species, and this variation, no doubt, will be still greater when a larger number of specimens are examined, particularly if they come from different localities. The number of vertebræ does not seem to promise much either. It is necessary at any rate that a larger number of specimens are examined before anything can be decided. In a *Z. punctatus* I have counted 9 + 26, and in a *Z. norvegicus* 9 + 25 vertebræ.

Although the number of fin-rays, as a character, must thus be used with judgment by the determination of the grown-up *Zeugopterus*, this is so much the more necessary where the young fish are concerned, which have not yet, perhaps, got all their fin-rays, and about which, at any rate, we do not know for certain if they have. I shall therefore, for a moment, leave this matter out of consideration.

In the seas within the Skaw there live only two species of the genus *Zeugopterus*, viz. *Z. punctatus* and *Z. norvegicus*. Of *Z. megastoma* only one specimen has been taken in the Skager-Rack, in 1868 (according to *Malm*). It must certainly be exceedingly rare there, and I doubt that it occurs there normally[3]). *Z. unimaculatus* has never been seen in Denmark or Scandinavia.

When, nevertheless, we find in the Cattegat the above mentioned two

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[1]) By the term *larva* I indicate all the young stages which have not yet got the form of the grown-up fish; consequently, as a rule till the persistent pectoral rays appear and the eyes have got the same form as in the grown-up fish. All pelagic stages therefore are larval stages.

[2]) According to my own investigation. The other numbers of the vertebræ are from Smitt's "Skand. Fiskar".

[3]) Cmp. Collett: "Meddelelser om Norges Fiske". Christiania Videnskabsselskabs Forhandlinger for 1903, No. 9, p. 89.

types of sinistral *Zeugopterus* larvæ, the smooth and the spiny one, it is, a priori, the most natural thing to suppose that they must belong to the two species of *Zeugopterus* which live in our seas, viz. *Z. norvegicus* and *Z. punctatus*. For our seas have been so thoroughly investigated with all kinds of fishing-gear, that I have no hesitation in saying that neither *Z. unimaculatus* nor *Z. megastoma* can have been overlooked within the Skaw, *if they really have their home here*. On the other hand, the possibility is not excluded, of course, that small young ones of these species can be carried into the Cattegat by currents. I know that this is the case with many other organisms. But here such a supposition is not very probable; more particularly because *Z. megastoma* is a deep-sea form, and *Z. unimaculatus is not known in the seas nearest to Denmark*. I suppose therefore that the two types of *Zeugopterus* larvæ must be referred to the two species that are found in our seas, viz. *Z. norvegicus* and *Z. punctatus*. *Z. unimaculata* is out of the question, with us as well as in Scotland, only in Danmark with greater certainty; for the rocky shores of Scotland can more easily hide it than our sandy beaches.

At this point my investigations have remained for a long time, as I was unable to prove to which of the two Danish species the smooth larvæ were to be referred, and to which the spiny ones. By the kindness of *Collett* and *Holt* I have now overcome this difficulty. Among the young fish of the genus *Zeugopterus* which *Holt* sent me from Ireland, was the only 9,5 mm long specimen of which a picture is given on table I, fig. 5. It was caught near the bottom, June 11., 1901, and evidently belongs to a very late larval stage, whose pectoral fins, however, are not yet fully developed. In its pigmentation it resembles much the 13 mm long specimen of *Z. punctatus* of which I, sometime, gave a picture in "Report IV", fig. 15; it was sent to me by Collett, who himself correctly considered it to be a young *Z. punctatus*. *Holt's* 9,5 mm long specimen had no spines on its head, but a rounded protuberance over the ear-region, on which they might very well have been placed. This specimen of *Holt's* also appears to belong to *Z. punctatus* by the whole form of its body, its lower jaw, the form of its dorsal and anall fins, its small and short caudal fin, and finally, its number of rays, viz., d. about 95, a. about 69. But besides that it reminds you, on the other hand, of such forms as those of which *M'Intosh* and *Mastermann* in "Food-fishes", pl. XIV, fig. 8, have given us pictures, and of which *Holt* has sent me a specimen from Valencia in Ireland, caught Oct. 12., 1897. By means of *Holt's*, I am sorry to say greatly damaged specimen, c. 10 mm long, with c. 98 dorsal and c. 73 anal rays, with distinct pairs of spines on, and of fig. 8 in "Food-fishes", I have drawn my fig. 4, table I. This figure, drawn from *M'Intosh's* fig. 8, with c. 87 d. and c. 62 a., and from *Holt's* above mentioned specimen, which were, both of them, spiny, is in the form of its lower jaw and of its tail, in length and pigmentation, very like my fig. 5; only with such alterations as may easily be explained

by the development of the fish, especially the loss of the spines on the head. From stages like fig. 4 we come easily to the younger spiny ones, fig. 1—2. The great number of fin-rays which we find in the here mentioned specimens, removes them, moreover, so decidedly from *Z. norvegicus* that there can be no doubt now that the series on table I, fig. 1, 2, 3, 4, 5, belongs to *Z. punctatus*, to which the spiny larvæ must consequently be referred. But I must confess that it is only after I have become acquainted with these above mentioned cogent reasons, that I refer the spiny larvæ to this species; originally I thought that they belonged to *Z. norvegicus*.[1])

From the above it follows that the smooth young fish must belong to *Z. norvegicus*. The rather high form of the body (cmp. my table I, fig. 6—7), certainly does not remind you much of the grown-up *Z. norvegicus*, which is rather slender; but the decidedly low number of rays does, and so does the form of the lower jaw. The number of rays in the dorsal, in the specimens I know (c. 7), is but little in excess of 80, though 82 and 85 are known. I am greatly astonished that *M'Intosh* has seen a smooth young one with c. 90 rays in the dorsal, but it is possible, of course, that he is right. Both *Holt* and *R. Collett* have sent me several young ones of the smooth type, by which I have been enabled to see that the transformation from pelagic young fish to the bottom stage takes place when the fish is about 10 mm in length, as in *Z. punctatus*. That I have non-transformed specimens of *Z. norvegicus* from the Shetland Islands, still pelagic, c. 11 mm long, cannot cause any astonishment, when we know the variations the development of flatfishes is generally subject to under unequal conditions, and that the transformation may be accompanied by a shortening of the length of the fish. In fig. 8 I give a picture of a 13 mm long *Z. norvegicus* from Norway (*Collett*), because it is pretty well preserved, and shows accordance with the grown-up fish in the number of fin-rays, as well as in the form of the body, the way in which the eyes are placed, the form of the mouth, the pigmentation and the size of the caudal fin. Collett has also immediately seen to which species it belongs. I believe that the two series of figures on table I, 1—5 & 6—8, will make it impossible in future to doubt that *Z. punctatus* has spiny larvæ with striped pigmentation, and that *Z. norvegicus* has smooth ones.

Besides the young ones belonging to the two said series, there are, in the collections gathered by the *Thor*, two which perhaps have been taken near the bottom, but which, to judge by their glassy appearance, are pelagic young fish with "otocystic" spines and evidently belong to quite another

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[1]) The 10 mm long *Z. norvegicus* which I mentioned in "De danske Farvandes Plankton, I", must therefore be referred to *Z. punctatus* (*Kgl. danske Vidensk. Selskabs Skrifter, 6. R., naturv. og math. Afdeling*, XII, 3, 1903, p. 260 & 250). — When the biology of these fishes has become further elucidated on the basis of the new particulars, information of the results will be given in the following papers.

species of *Zeugopterus*. They were caught in young-fish trawl (amodytes-seine trawl) at the Shetland Islands, Septbr. 11., 1903, in water 64 fathoms deep. In spite of the early stage of their development they are 13 & 14 mm long. There is a picture of the largest on table I (fig. 9). They are consequently much longer than the nearly quite transformed *Z. punctatus*, which is the basis of figure 4. This alone prevents us from referring them to *Z. punctatus*, but they are also otherwise very different from the somewhat corresponding stage, fig. 2, for instance with regard to the pigmentation. Their pigmentation is more like that of *Z. norvegicus*, but their spines show that they have nothing to do with this. I suppose that they belong to the species *Z. megastoma*, which is common in these parts. I do not possess, however, all the transitional stages of this species, but I have several, somewhat older specimens, from a length of 27—32 mm, taken by the *Thor*, at the bottom, near the Vestmanna Islands at Iceland, with young-fish trawl, on a depth of 120—400 meters, in the summer of 1903. One of these, c. 29 mm long, table I, fig. 10, has evidently lately given up its pelagic life, for it has still large larval pectoral fins. It has still, however, distinct pairs of spines in the ear-region, of the the type which we find on *Z. punctatus*; on the older specimens, on the other hand, these spines are disappearing. That these larvæ, belonging to the bottom-stages, are larvæ of *Z. megastoma*, is proved by the number of their fin-rays, c. 90—96 dorsal and c. 72—74 anal rays, besides by their quite external great resemblance, in other respects, to this species, which was found in large numbers, as a grown-up fish, by the *Thor*, among other places also in the same regions. Moreover, no other *Zeugopterus* is known here on somewhat deeper water. *Z. norvegicus*, on the other hand, must be found near Iceland, in places where the water is rather low, because its little smooth young ones, according to the above, have been shown to live there. The grown-up fish, however, have not yet been found, because the place, in spite of all, has not been thoroughly investigated.

(In the Faroe-Islands I have found a somewhat smaller number of rays in *Z. megastoma*, than I found near Iceland, viz., 86—91 dorsal and 66—72 anal rays; but only 5 specimens from this place have been examined. The numbers will probably prove to vary still more, but it is quite possible that they, as a rule, are larger near Iceland; this is the case, at any rate, with *Drepanopsetta*. In "Ann. Mag. Nat. Hist.", Dcbr. 1899, *Günther* informs us that *Zeugopterus boscii* has 80—81 rays in the dorsal and 63—65 in the anal, but I think very few specimens have been examined.)

At first I rather doubted that the large, spiny young ones (table I, fig. 10) belonged to *Z. megastoma*; for *Holt* has (l. c. plate XV, fig. 116, 117) two pictures of young specimens of *Zeugopterus*, 19 & 30 mm long, which according to his statement have no spines, and these specimens he refers to *Z. megastoma*, stating that he had "a complete series" from 19—56 mm. Now the matter is that his longest specimens (see his fig. 118) very much

resemble *Z. megastoma*, but it is scarcely probable that this species, already when it is 19 mm long, should lose its spines near Ireland, when it keeps them in the neighbourhood of Iceland till it is as long as 27 mm. I take it for granted, however, that such a skilful investigator as *Holt* cannot have overlooked the spines, if they had been there; and it struck me, therefore, that at least his small specimens without spines do not belong to *Z. megastoma* at all, but to another species. When this doubt had once risen in my mind I saw that *Holt* himself (l. c. page 74) is astonished that the small young ones resemble "*Rhombus boscii* (Risso)" much more than *Z. megastoma;* but he supposed that this would change later on. No, this supposition is scarcely correct; for this little, 19 mm long young one, table I, fig. 11, is fully developed with persistent pectoral rays and large eyes, as the grown-up fish. It will hardly change its form. But it agrees in form very closely with "*Rhombus boscii* (Risso)", as *Holt* himself says, and is much higher over the pectoral fins than *Z. megastoma.* In order to obtain better information of the Irish "*Rhombus boscii*" I asked *Holt* to send me a grown-up specimen, and he was kind enough to do so. I had thus an opportunity to see that this small species (c. 20 ctm. long) in the form of its body and size of its eyes agrees very closely with my fig. 11, which I have copied from *Holt, and that it was a true Zeugopterus, not a Rhombus*, for it had a perforated isthmus like the other species of *Zeugopterus.* Because it is a smaller specimen, probably, it loses its spines at a shorter length than *Z. megastoma,* and this, I think, explains why *Holt's* figures 116 and, perhaps, 117 have no spines. In "Ann. Mag. Nat. Hist.", December 1889, page 418, *Günther* has given the correct information that the large eyes are characteristic of *Z. boscii* in contradistinction to *Z. megastoma;* but I shall here caution against a comparison between my figures 11 & 10, as the latter belongs to a larval stage (the pectoral fins) while figure 11, on the other hand, is fully transformed. I do not possess any *Z. megastoma* belonging to a stage corresponding to figure 11. Loc. cit. *Günther* says that both the said species have vomer-teeth, and therefore, properly, ought to be removed from the genus *Arnoglossus,* to which he has provisionally referred them. This is quite correct, of course. They are, both of them, true species of *Zeugopterus,* as we now know.

According to the above it must be considered the rule then, that the larvæ of the genus *Zeugopterus,* at a certain stage of their lives, have *"otocystic"* spines, i. e. a pair of spines on either side of the head, in the ear-region. We know only one exception from this, *Z. norvegicus*, which as a young fish has no such spines at all. This agrees very well with the fact that this species, as *H. M. Kyle* has verbally informed me, from osteologic and other reasons, must be imagined to be the one which is farthest removed from the other species of the genus *Zeugopterus.*

Explanation of the Table. — Table I.

Fig. 1. *Zeugopterus punctatus.* From *Holt* (Trans. R. Dub. S. (N. S.), vol. V. Fig. 94. "R. lævis, or R. norvegicus?"). 7 mm long.
» 2. » » » » (l. c. Fig. 95) $10_{\frac{9}{12}}$ mm, d. c. 80, a. c. 66.
» 3. » » » » (l. c. Fig. 97). Shows the pair of spines in the ear-region, the "otocystic" spines.
» 4. » » Partly from a specimen sent me by *Holt*, c. 10 mm lang; d. c. 98, a. c. 73; partly from *M'Intosh* (Brit. Mar. Food-Fishes, plate XIV, fig. 8).
» 5. » » Sent by *Holt*. $9_{\frac{5}{5}}$ mm long; d. c. 95, a. c. 69.

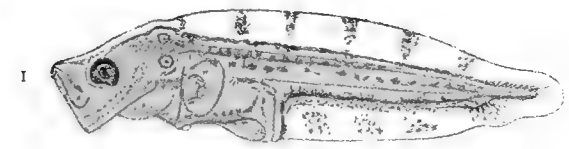
» 6. *Zeugopterus norvegicus.* From *Holt*: l. c. fig. 89. $5_{\frac{8}{8}}$ mm long. "Species XIII".
» 7. » » » » l. c. fig. 93. $9_{\frac{3}{3}7}$ mm long. "Species XIII". D. more than 80, a. more than 60.
» 8. » » Sent by *Collett*. 13 mm long, d. c. 84, a. c. 71.

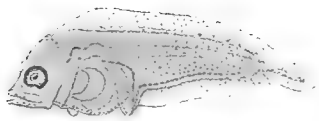
» 9. *Zeugopterus megastoma.* 14 mm long. The Shetland Islands. Septbr. 11., 1903.
» 10. » » 29 mm long, d. more than 87; a. more than 72.

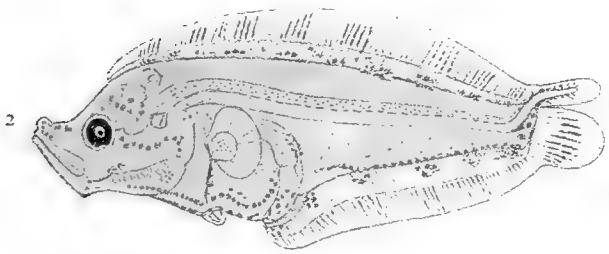
» 11. *Zeugopterus boscii?* From *Holt*: l. c. fig. 116. 19 mm long.

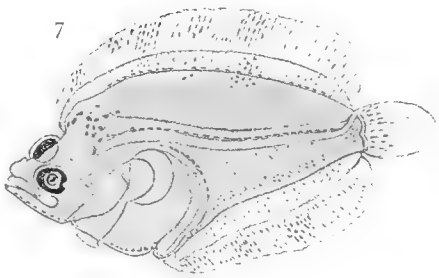
The figures 5, 8, 9, & 10 are original and drawn by means of a prism.

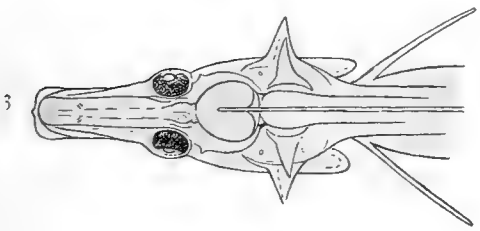
PLATE I

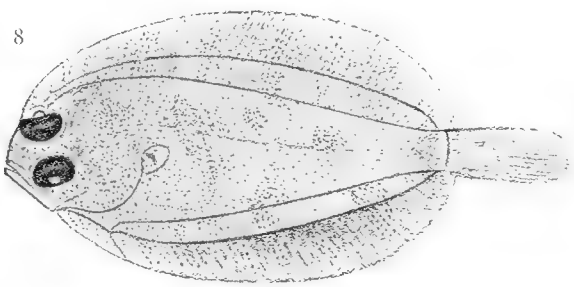


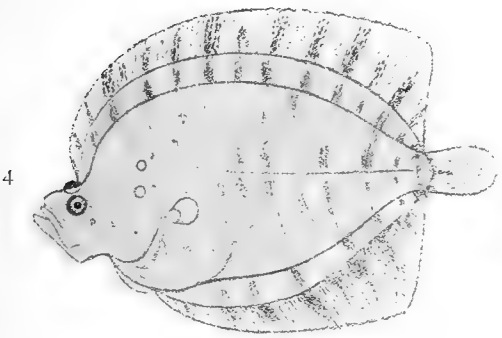


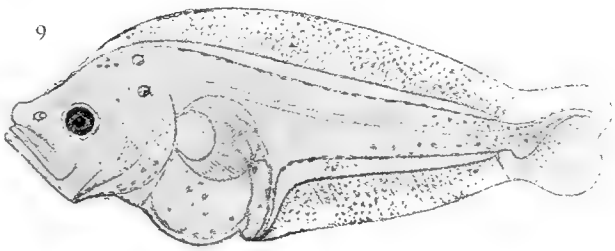


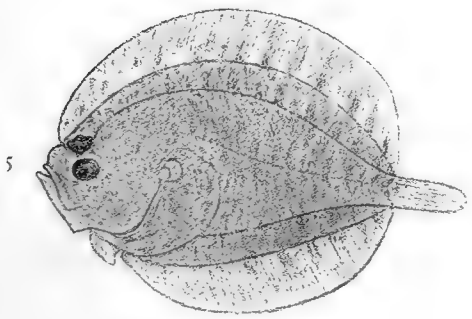


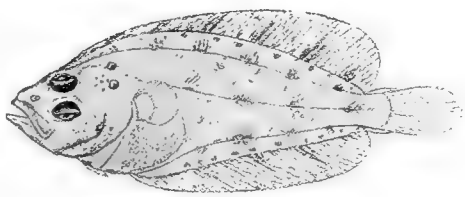


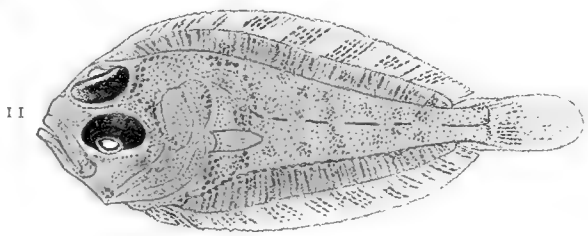












WESTERGAARD DEL.

P. PETERSENS BOGTRYKKERI, KPHVN.

III.

Can we enter into Competition with the Foreign Steam-trawlers in our Seas outside the Danish Territorial Limit?

By C. G. Joh. Petersen.

It is a great advantage to the fisheries in Denmark proper that the fishermen need but go a very short distance from our principal market, Copenhagen, to reach the fishing-places. This makes it possible to carry the fish to the market not only in fresh (unsalted) condition, without ice, but often living. The goods are therefore first class, and can fetch very high prices. I believe there are few places in the world where the fishing is carried on so skilfully and gives such a large income, within such a small district as our fjords, belts, and shores within the Skaw. But, on the other hand, it is only of the fisheries on our shores, in *low water*, that I can speak in this way. In the more open seas, the North-Sea, the Skager-Rack, nay even in the deep eastern part of the Cattegat, we are behind our neighbours in turning the stock of fish to our profit. The only fishery of any greater importance which we carry on in these seas is the plaice-fishery, which, as it is well known, is based on the catching of living plaice at rather high prices, and is carried on with seines from welled smacks on depths which, as a rule, are less than c. 30 fathoms. Nearly all other species of fish from the deeper parts of these more open seas, haddocks, cod, pole dabs, etc., we leave to Sweden, Norway, England, Germany, etc., whose fishermen here, on depths down to c. 150 fathoms, but in the immediate vicinity of our shores, catch annually for millions of Kroner of fish, which they sell in all other countries than in Denmark. What we catch along the western shore of Jutland — when we except the plaice-fishery — is little compared to the fishery carried on here by foreigners. The reason of this is, partly, that we have only one harbour on the western shore of Jutland; but this is not the principal reason.

Both the general public and members of the Rigsdag have so often declared that Denmark, after all, must have a better chance of carrying on

the fishery profitably in our neigbouring seas than, more especially, England and Germany. For the foreigners must sail the long and expensive way with their steam-trawlers, both from and to their homes, in order to fish on our fishing-grounds; and if this can be profitable to them, it must be still more profitable to us to carry on these fisheries. Yes, *probably it is so*; but it must be remembered that the price of coal is somewhat lower in England than in Denmark, and that there is both in Germany and in England a much greater, already well-established, market for trawl-caught fish than in Denmark. When I have formerly regarded this matter as quite hopeless in Denmark, the reason is, more particularly, that a certain circumstance connected with it has not been clear to me till quite lately. I have not thought it possible that the fish the trawlers take, haddocks, cod, deep-sea flatfishes, etc., could fetch acceptable prices in Copenhagen; for trawl-caught fish, as everybody knows, is not living. The steam-trawlers generally catch such large masses at a time in the trawl, that the fish is squeezed to death in the trawl while being hauled in. Such fish are therefore not first-class goods like our usual, living fish. The trawled fish is iced in the warmer season, after it is cleaned; in the colder season, which on the whole will be the best if not the only time for trawling, this is not necessary. The trawl-caught fish, which is the principal commodity on the European inland market, is as yet but little known here. But these last winters a couple of small trawlers (one with steam and another with sails and auxiliary engine) have carried considerable quantities of all kinds of fish, from soles, turbots, and plaice to cod, haddocks, lemon dabs, etc., to the free-port of Copenhagen, where they have had a ready sale, though the fish are not so good as living fish, *only because the price is lower*. There is, consequently, an indication here, that Copenhagen will eat second-class fish, if obtainable at proportionate prices. This was the circumstance of which I wanted information.

It is scarcely necessary to state that fish is nearly always very dear in Copenhagen, i. e. first-class plaice, cod, and other living fish. 50 Øre per pound of plaice and 25 Øre per pound of cod are not uncommon prices, and it seems *that second-class fish is always rare in this city, at any rate at low prices.*

In order to be able, in rough outlines, to make a comparison with Germany, where the market is based on trawl-caught fish, I shall mention the average prices for 1903 in Geestemünde harbour, where more than 100 steam-trawlers land their fish, chiefly caught in the North-Sea, the Skager-Rack, and the Cattegat.

According to the official statistics of Geestemünde for 1903, the average price for cod was c. 11 Øre per pound, for plaice c. 13 Øre per pound, and for haddock c. 8 Øre per pound. These are auction-prices, consequently wholesale prices, and I want expressly to say that we can never expect to obtain, even approximately, such good fish as those which are sold at present in Copenhagen, at such low prices. Most likely, it will never happen; for there is so great a

difference in quality between these commodities that they, in my opinion, will never compete in our Danish market. There will always, I dare say, be people to buy the good, living fish; but these fish are and must be looked upon almost as a luxury. I only mention how matters are standing in Germany, to show that trawling gives inferior, but cheap fish; and it is my opinion now, that many people in Copenhagen will be willing to buy these fish, who, as a rule, never before had fish on their table.

It is possible, consequently, provided that the general public will be inclined to buy the fish, that it will pay to carry on trawling from Copenhagen, because we are situated nearer to the fishing-grounds in the North-Sea, the Skager-Rack, and the Cattegat than most nations; and it would be a great advantage, particularly to the less wealthy part of the population, more especially in Copenhagen, if cheap fish, even though of second quality, were carried to the market by the trawlers.

I could imagine now that the introduction of trawling into Denmark (whether carried on by means of larger steam-trawlers or by a number of our fishing-smacks, changed in such a way that they could use small trawls or otter-seines) would be objected to as an *injurious* way of fishing: 1) because it destroys the stock of fish; 2) because it will set up a competition with our present fishermen; and, finally, 3) because it will give the management of the fisheries into the hands of capitalists and so produce a number of hired people, who would otherwise be independent owners of their small vessels.

Note. We have in Denmark for many years heard of trawls and trawling, but only few people here know what a trawl is. We have heard our fishermen complain that foreigners are trawling near our shores, although on international sea-territory, and thereby preventing their usual fishery with nets and seines. These complaints are nearly all that the general public knows about the trawl. The ideas of injuriousness in general, and of trawling, have thereby become so mixed up in Denmark that it will be no easy task to place them in the relation to one another which sober truth demands.

It appears, however, that the legislative power labours under so great difficulties in laying down a fixed rule for what a trawl is, and what a seine is, that different results have often come out of it. *Both of them are more or less bag-formed nets which, spread out in different ways, are dragged along the bottom.* The worst objection we, from a technical point of view, can raise against the large trawls, used by steamers and large sailing-vessels, is, that it is often impossible for them to bring the catch living on deck and here separate the fish which are fit for use from the useless ones, while they are still alive. In other words, they are most frequently prevented from placing the fry again in the sea in a live state. This can be done with most of our seines. But these are generally employed on lower water, where it is always easier to get the fish up alive. The trawls, on the other hand, are usually employed on deeper water, where it will generally be impossible, with any kind of fishing-gear, to bring the fish living on deck, because the fish suffer too much, already by being brought to the surface from the deeper water. What is really characteristic of trawling is that it is carried on with large, powerful boats, day and night, in

good or bad weather, on low, but particularly on deep water, and, finally, that the boats catch large numbers of fish, generally so large numbers that the weight of the fish themselves, during each hauling-in, is enough to kill most of them, so that they cannot be delivered to the market in living state.

As to the stock of fish, then, it is seen by the statistics of our fisheries, that Danish fishermen catch for c. 2 million Kroner of plaice annually in those of our seas where foreigners are now trawling and where, consequently, also our own trawling should be carried on, namely the North-Sea, Skager-Rack, and the deeper parts of the Cattegat; in all three seas *on international territory where the fishermen of all nations, consequently also the Danish, are permitted to fish.* But of *all other fish together* (including cod, haddocks, lobsters, oysters, herrings, mackerel, etc.) they also catch only for about 2 million Kroner. The plaice are, consequently, absolutely predominant, and *the reason is that we chiefly fish for plaice, and carry on the fishery on low water.*

If, on the other hand, we look over the accounts of the somewhat more than 100 steam-trawlers which land their catch at Geestemünde, then we see that the plaice give only 280,000 Marks of the c. 5 millions, which came in at the public sale in 1903, *but the other species of fish altogether c. 18 times as much.* Among these other species of fish we find that "small haddocks of the fourth sort and whitings" give the largest amount given by a single class of fish, viz. between 6 and 700,000 Marks, and they sell at $5^1/_4$ Pf. per pound. Haddocks give, all in all, more than 2 million Marks, cod c. 1 million, pole dabs 400,000 Marks, green cod 150,000 Marks, soles 190,000 Marks, turbots 140,000 Marks, and the remaining amount is distributed over a number of other fish of less importance, which are seldom, if ever, sent to the market in Copenhagen.

It will be seen, then, that the trawlers do not particularly pursue the plaice in these seas, as our plaice-seine fishermen do. We may rather say that these two ways of fishing supplement each other. One is based on plaice on low water; the other on roundfish on deeper water. This is why our plaice-seine fishery has been able to thrive very well, on the whole, beside the foreign trawlers in our neighbouring seas; and I do not think our principal fishery will get into danger, if we add a few Danish trawlers to the international trawling-fleet. They will not catch such large numbers of plaice that it will be of any consequence, compared to what we ourselves catch of this fish in other ways; and it is particularly this fish that needs protection. I believe, therefore, that Denmark can take part in the trawling on international sea-territory, i. e. outside our fjords and belts and the lower parts of the Cattegat, without any fear of destroying the stock of fish (stock of plaice). Whether the deep-sea stock of fish, as a whole, can bear a great addition to the existing fleet of trawlers is another question, though presumedly one which belongs to the future; and its solution will scarcely be affected by the presence of a few Danish trawlers.

It must not, therefore, prevent us from taking part in the international progress in fishery. It does not appear that the foreign nations pay regard to such matters; and to stop their development is at any rate beyond our power.

Indeed, we must hope for an international protection of the stock of fish, where protection is needed; and, no doubt, a prohibition against trawling at certain places would be desirable, perhaps in certain months of the year. But a general prohibition against trawling in all the deep parts of our seas will presumedly be quite out of the question; for by trawling only, I think, it will be possible to make an adequate profit out of the large deep-sea stock of haddock in winter.

As the trawling in the said seas is not based particularly on plaice, it is my opinion that also the second objection, that it sets up a competition with our own fisheries by bringing cheap fish on the market, will be of no greater weight, except perhaps with respect to the cod-fishery. But cod and haddock caught on hook is a far better commodity than the trawl-caught fish, also abroad, and cod taken in traps is living. I do not see how the trawl-caught fish, which is to be bought by a quite different class of people, will be able to do any greater harm. But I do see *that we profit too little by* the roundfish (cod, haddocks, gurnards, etc.) and deep-sea flatfish (pole dabs) which live in the deeper parts of our seas, and whose numerousness, through a great part of the year, has been proved by the investigations carried on by "Kommissionen for Havundersøgelser", through Dr. *A. C. Johansen,* on board the steam-trawler *Thor.* German, English, and Swedish trawlers take, for the present, by far the greater part. Scores of times I have seen the German steam-trawlers pass southward through the Great Belt, bound for Hamburg, loaded with fish taken in the immediate neighbourhood of our shores, but on international sea-territory. Our territory, it must be remembered, is only 3 miles broad.

As to the third objection, that capitalism might possibly acquire an undesirable influence, I shall say only that trawling is the only fishery that can be carried on where the foreign trawlers are (the otter-seine I look upon here as a sort of trawl); everything else will be molested by the trawling vessels. We must trawl, consequently, if we will not quite give up the idea of getting some part of the profit. Moreover, it will scarcely be a large fleet of trawlers we can expect to supply Copenhagen with fish, and as already mentioned, our fishing-smacks with powerful motors will possibly be able to partake in this fishery. The latest experiments with such vessels in Germany seem to prove that a fishing-smack with a motor of 16—20 H. P. can drag a trawl some 50 feet in width. Finally, one thing more: if the prices for trawl-caught fish do not remain high enough in Germany, then *the German trawlers can sell their fish in Copenhagen, whenever they like.* No one can forbid them to do so; they are going to Frederikshavn already, now and then, with their catch; and rather than that should

happen, it seems to me, that we must overlook any possible smaller drawback to the introduction of trawling. But if we consider it our principal object, to procure cheap fish for Copenhagen, then we could simply make an arrangement with German or English trawlers about the delivery of fish for Copenhagen; we should then run no risk by starting a great undertaking with Danish capital.

I have now, I think, stated the whole matter, and enlightened it from all sides, such as it appears to me. When I have not before expressed any opinion as to the possibility of trawling with large vessels from Denmark in order to supply the Danish market, the reasons are: the difficulty in seeing whether there are here buyers for the trawl-caught fish, and the fact that I did not know that the number of fish was sufficiently large on our shores through such a great part of the year (at least from October till May). It must be remembered that the question is here particularly of roundfish, migratory fish consequently, and pole dabs. When earlier Danish steam-trawl companies, which have employed Danish vessels, have not carried the fish to Copenhagen, I must suppose they have had particular reasons for it; but this need not prevent others who might desire to try such trawling from a Danish harbour.

One should think that it is in itself a handsome object for private enterprise, to supply Copenhagen and the rest of Denmark with cheap fish, as it must be looked upon as a patriotic task to set up a competition with the foreign nations in our own seas. If my exposition of the matter can help to call up private initiative, I should be glad. For besides this, my only intention with the above has been to make it clear how we are standing in this matter as regards foreign countries, and to free myself from the responsibility I should feel by being silent about it.

How to enter upon it in the best way, is a question I shall not discuss here. There are many possibilities; but the object must be: *to obtain for Copenhagen a constant supply of cheap, trawl-caught fish.* That the practical accomplishment of this whole matter will meet many difficulties, I shall only mention. One of these difficulties will, doubtless, be the sale of the fish, as it would be necessary, sooner or later, to get a suitable covered fish-market where the public sale could be held. But with regard to this I think that the undertaking may reckon on the powerful support of the municipality of Copenhagen, as this city first and foremost would benefit by the new enterprise. To prepare the transition from the present state to something better, the catch might also be sorted at Frederikshavn, or in the new harbour at the Skaw. Part of it could then be sent by rail to Hamburg where, for the time being, there is an unlimited market for trawl-caught fish. It would then be necessary only to sail the few miles from Frederikshavn to Skager-Rack, where no doubt the principal fishing-grounds will be situated.

It has often been discussed, in private conversations, whether we ought in Denmark, as it has been done abroad, to go over to the sale of *killed* instead of *living* fish. This is not what I here propose. We should, decidedly, always continue to produce all the good, living fish we can; but we ought not, for that reason, to neglect benefiting also by the fish which cannot be brought to market in living state. Even though they turn out to be of second quality, we learn from the German statistics that this is to a high degree compensated for by their number and cheap price.